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NEW SERIES. DECADE V. VOL. I.

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LIST OF PLATES.

PLATE		FACING PAGE
I.	*Cupressinoxylon hookeri*, Arber, sp. nov.	7
II.	Examples of erosion of rocks in Corsica	12
III.	Portrait of the late R. Etheridge, F.R.S. L. & E., F.G.S., etc.	49
IV.	Portrait of the late Professor K. A. von Zittel	90
V.	*Phacops Robertsi*, Reed, sp. nov.	109
VI.	Mammals of the Eocene of Egypt	162
VII.	Borings at Cunapo Coalfield, Trinidad	198
VIII.	Trinidad Foraminifera	249
IX.	Trinidad Foraminifera	250
X.	Portrait of the late Charles Emerson Beecher, Ph.D.	284
XI.	Eocene Echinoids from Sokoto	304
	Sketch-map of River System of Equatorial Africa	344
	Sketch-map of Lake Tanganyika	368
XII.	*Phacops* and *Encrinurus*	383
XIII.	Eroded Granite Boulder, near Ajaccio, Corsica	390
XIV.	Portrait of W. H. Hudleston, J.P., M.A., F.R.S., F.L.S., F.G.S.	431
XV.	*Linthia oblonga* (Orbigny)	445
XVI.	*Desorella elata* (Desor)	480
XVII.	Shell of *Testudo Ammon*, Andrews	527
XVIII.	Natural Arch in Limestone, Torquay	608

LIST OF ILLUSTRATIONS IN THE TEXT.

PAGE

Cupressinoxylon hookeri, E. A. Newell Arber, sp. nov. 9, 10
Partially Silicified Crystalline Limestone 17
Suture-line of *Pericyclus fasciculatus* 29, 30, 31
Tongue of Clay in Chalk 73
Middle portion of above, enlarged 73
Skull of *Mœritherium* 110
Skull of *Palæomastodon* 113
Section showing junction between the Lias and Cretaceous 125
General Section of Black Ven 127
Junction between the Selbornian and Lias of Black Ven 128
Section in the Selbornian of Black Ven 130
Lower Keuper basement-beds 171
Sketch-map of Afon Seiont below Pont Seiont 201
Sketch-map of Nant Rhos Ddu 205
Section across Nant Rhos Ddu 206
Diagram-Section of *Gonatosphæra* 242
Diagram to illustrate the Phylogeny of *Nodosaria* and allied forms 249
Succession of beds in the folded region of Cape Colony 253
Eocene outcrop in Central Africa 291
Plesiolampas Saharæ, Bather, sp. nov. 294
Contorted pegmatite vein in granite, Sweden 310
Folded pegmatite in a sett quarry, Sweden 310
Contorted pegmatite in gneiss, Sweden 311
Pegmatite vein in granite, Sweden 312
Curves showing the frequency of branching in *Stomatopora* 320
Diagram showing method of branching in *Stomatopora* and *Proboscina* . . . 321
Plan of the Graben System and its relation to the Congo Basin 355
Section across British East Africa 357
Section of the Lower Congo between the Atlantic and Stanley Pool 361
Structure of a Graben 368
Hollow in granitic block 389
Sections to illustrate Dr. Bonney's paper 389, 390

PAGE

Section from Fremington and Eastcombe to Clayhanger, etc. 394
Section through Coddon Hill Beds, Barnstaple 396
Diagram of longitudinal sections of forms of *Actinocamax* 409
Sketch-map of zircon granites near Balangoda, Sab, Ceylon 419
Structure of allanite granite 422
Diagram to illustrate Mr. Vaughan's paper 427
Cypridina antiqua, Jones, sp. nov. 439
Section at Clapham, north of Bedford 440
Bones of *Algoasaurus Bauri*, Broom, gen. et sp. nov. 446
Apical disc of *Desorella elata* (Desor) 480
Map of Earthquake-area near Penzance 488
Section from Idak to Mirán Shah 491
Belemnite and *Crioceras* (?) from Mesozoic rocks, Mirám Shah, N.W. India . 492
Diagram of carapace of *Testudo Ammon*, Andrews 528
Diagram Map of Hessle Earthquake 537
Diagram Map of Strontian Earthquake 538
Diagram Map of the Kishon and Jordan Valleys 577
Figure of skull of *Notochampsa Istedana*, sp. nov. 583
View of Unconformable Junction of Hornstones with Highland Schists, Arran. 594
Diagram Figure of Natural Arch, Torquay 613

THE

GEOLOGICAL MAGAZINE.

NEW SERIES. DECADE V. VOL. I.

No. I.—JANUARY, 1904.

ORIGINAL ARTICLES.

I.—A Retrospect of Geology in the last Forty Years. (Part I.)

THE completion of the 40th volume of the Geological Magazine, and the commencement of its Fifth Decade under the Editorship of one who has been responsibly associated with the undertaking since 1864, and has been Editor-in-chief since July, 1865, furnishes a fit opportunity for a retrospect.

In the opening pages of this Magazine Professor Rupert Jones dealt with "The Past and Present Aspects of Geology." He remarked on the tendency to encroach upon the theory of Uniformity, upon the right "to call in the agency of forces which, though not seen in operation in nature, may be evoked in the laboratory." He further referred to "recent discussions respecting the origin of granite, the mode of formation of river-valleys, the excavation of lake-basins, the doctrine of 'homotaxis,' and the origin of species." At that time, owing to the teachings of Huxley, there was more scepticism than there is now as to the exact truth of "the contemporaneity of strata which contain the same or similar fossils, and which are geographically far apart."

All these and many other subjects at home and abroad have been discussed in our pages, the aim (as stated in the January Number, 1866, p. 1) having been "to enlarge the opportunities of preserving the results" of the labours of the ever-increasing number of geologists, and "to supplement, as far as possible, the authoritative and old-established Journal of the Geological Society."

Throughout this long period the material at our disposal has been abundant, and the importance of the greater part of it has been acknowledged: indeed, we may claim to have published many an essay that is now regarded as a classic; while among them we may count perhaps a few of the 'Rejected Addresses' that a too conservative element in former Councils of the Geological Society thought right to discountenance.

Looking back over the forty volumes, our pride and satisfaction are not unalloyed with a reasonable amount of humility, such as everyone naturally feels with a work that has been accomplished.

Some articles, indeed, might with benefit have been curtailed, a few might perhaps have been omitted without detriment to science, while here and there asperities in correspondence might have been softened or removed with evident advantage.

Our First Decade was characterized by many articles and much discussion on various forms of Denudation, in which Scrope, John Ruskin, Jukes, Colonel George Greenwood, O. Fisher, D. Mackintosh, Hull, Whitaker, Green, Kinahan, Topley, and others took part. Escarpments and valleys, lakes, and the relative importance of sea *versus* rivers came again and again to the front, the last-named subject being dealt with in a masterly way by Whitaker in his classic essay on Subaërial Denudation. The origin of the Chesil Beach and the adjacent features was considered, and even the ancient valley system of Pre-Triassic times in the Bristol area and Charnwood Forest, which has quite lately been a subject of interesting observations, was briefly discussed by G. Maw.

Glacial geology and the causes of changes of climate occupied the attention of S. V. Wood, jun., James Geikie, James Croll, W. Boyd Dawkins, and D. Mackintosh; and Geological Time was also brought before our readers.

The study of Igneous rocks with microscopic aid came into prominence. Interest was stirred up by P. H. Lawrence's translation of B. von Cotta's work, "Rocks Classified and Described." David Forbes and Samuel Allport dwelt on the importance of the study and gave an impulse to research. Forbes and Sterry Hunt entered into controversy on certain questions of chemical geology.

The recognition of 'Eozoon' as a foraminifer was in these early days largely accepted. It was held to have built up in reef-like masses the limestones since altered into marbles in the great Laurentian gneiss of Canada. Eozoonal structure was also seen in the green and white marble of Connemara.

Sir Roderick Murchison wrote on the Laurentian rocks of Britain, Bavaria, and Bohemia; and cores of the ancient gneiss (now grouped as Archæan) were recognized by H. B. Holl at Malvern and by others elsewhere.

Hicks, aided at first by Salter, commenced his brilliant researches among the Lower Palæozoic rocks of Wales, and the results of some of these, together with the now classic paper of T. Belt on the Lingula Flags, are included in the volumes. Hughes dealt with the break between the Upper and Lower Silurian rocks of the Lake District, in a paper which (if we are rightly informed) found little favour in the eyes of Murchison.

Other topics received treatment; J. Ruskin wrote on Banded and Brecciated Concretions, S. P. Woodward on Banded Flints, John Morris on the Oolites and Lower Cretaceous rocks, and Meyer on Cretaceous rocks, while G. Maw described interesting pockets of white clay, etc., in the Carboniferous Limestone of North Wales, Derbyshire, and North Staffordshire.

In the Second Decade the desirability of having a detailed record of geological and palæontological literature was brought

prominently before the Editor. A small Committee met in his study during the winter of 1873–74, and as a result brief abstracts of geological papers were for a time contributed with some regularity to the GEOLOGICAL MAGAZINE. The Committee consisted of Henry Woodward, Prof. Williamson, F. W. Rudler, L. C. Miall, W. Topley, W. Whitaker, G. A. Lebour, W. Carruthers, and H. B. Woodward. It soon became obvious that the GEOLOGICAL MAGAZINE was not large enough to embody all the abstracts that were forthcoming. This led on to the establishment of the "Geological Record" under the editorship of Whitaker, and for a few years an excellent and carefully edited annual volume was published, with the aid of a grant from the British Association. Difficulties, however, arose, and that work was ultimately abandoned when the "Record" was brought up to 1884.

In this Decade Pleistocene geology again occupies a prominent position in the Magazine, and Sir Henry Howorth appears on the scene with essays on the Mammoth in Siberia and its extinction, and on the evidences which he pictured of a great Post-Glacial Flood. The Lôess is discussed by Baron von Richthofen, Howorth, and Nehring. Ice-work in Newfoundland is described by J. Milne, and special attention is called to the action of coast-ice. R. D. Darbishire discourses on the drifts at high levels at Macclesfield; and the Recent and Pleistocene geology of Cornwall was treated of in essays by W. A. E. Ussher.

The subjects of Climate, Continents, Mountains, and Escarpments are again discussed; and W. Flight discourses on the History of Meteorites. Judd deals with the study of Volcanoes, and in an article on the origin of Lake Balaton, in Hungary, he so far questions the glacial origin of certain lakes as to rouse a storm of opposition from Ramsay, J. Geikie, and others. J. Milne turns from the subject of Glaciers to Volcanoes, and finally to Earth Movements.

Among the older rocks, and especially in the structure of the Scottish mountains, a great advance is made: in the classic paper by Lapworth on the Secret of the Highlands, and in papers by Hudleston on Assynt, and Hicks on parts of Ross-shire.

The older Palæozoic rocks are dealt with by Hicks and Lapworth, and the Devonian by Champernowne.

The relations of Permian and Bunter are freely discussed; while the palæontology of the Yorkshire Oolites forms the subject of another classic paper by Hudleston.

In Petrology we have the important essay by Teall on the Cheviot Andesites and Porphyrites; while of general papers, that on the geology of Spitzbergen, by A. E. Nordenskiöld, and the "Travelling Notes" of J. Milne, across Europe and Asia, are specially noteworthy.

In the THIRD DECADE the subject of Metamorphism is largely dealt with, the effects both of contact with intrusive masses and of earth stresses being discussed. Serpentine in particular comes in for treatment. Teall deals with the origin of Banded Gneisses and with the metamorphism of the Lizard Gabbros—a subject into which Bonney and McMahon enter in discussion. The schists of

Bolt Head are dealt with by A. R. Hunt, and he is not suffered by Bonney to go free from criticism.

Eozoon again comes up, Sir J. W. Dawson making one more appeal in favour of its organic origin.

Callaway deals with Archæan. The 'Monian' system of J. F. Blake is also discussed, and Hughes writes on the Cambrian of North Wales.

Notable are the articles by Lapworth on the Close of the Highland controversy, on the Cambrian rocks of Nuneaton, and on the Olenellus Fauna in Britain. He likewise defines his Ordovician System, and writes on the Ballantrae rocks. Nicholson and Marr deal with the Lower Palæozoic rocks of the Lake District.

The Culm-measures of Devonshire, Coal in the south-east of England, the Trias, the Neocomian, and the Bagshot Beds come in for a good deal of attention.

A. Harker, as well as T. H. Holland, appears on the scene, and they, together with G. A. J. Cole, describe various igneous rocks; while Judd writes on the lavas of Krakatoa, and Teall on the Cheviot quartz-felsites and augite-granites.

The mineralogical constitution of calcareous organisms forms the subject of an important paper by V. Cornish and P. F. Kendall. Pisolite is dealt with by Wethered; explosive slickensides by Strahan; Earthquakes, the creeping of soil-cap, and the stone-rivers of the Falkland Islands by Davison; Dust and Soils by C. Reid; while W. M. Hutchings writes on Slates and fire-clays. Landscape Marble, the flexibility of rocks, faults, jointing, and cleavage also receive consideration. Howorth continues to write on the Mammoth and the Glacial Drift; others deal with the Caves of North Wales, and with Moel Tryfaen, while Geological Time, the permanence of Continents, and geological nomenclature attract several writers.

In the Fourth Decade the life-zones of Carboniferous and Cretaceous rocks are specially dealt with, while those of earlier and later date come in for a certain amount of discussion. The zones of the Carboniferous system had been neglected, but Marr, Garwood, and Wheelton Hind come to the rescue, and it is well known that Traquair and Kidston are also keenly interested in the subject. The admirable work of A. W. Rowe on the Chalk zones is reviewed, and Jukes-Browne discusses the possibility of making 'chronological maps,' which no one has yet attempted except on a small scale or in a general way.

The nomenclature of Igneous rocks is discussed by H. Stanley Jevons, and the new American classification is criticized without favour. The order of consolidation of minerals in igneous masses receives attention from Sollas, while Harker describes the sequence of igneous rocks in Skye. Greenly gives accounts of various Anglesey rocks; Bonney and Miss Raisin deal with rocks from Kimberley in Cape Colony, Teall with Nepheline-syenite from north-west Scotland, McMahon with the granite of the Himalayas, and A. R. Hunt with that of Dartmoor. J. Parkinson and H. J. Seymour describe sundry igneous rocks. Hutchings discourses on

the Great Whin Sill, on clays, shales, and slates, and on contact metamorphism, T. H. Holland on Laterite, W. F. Hume on the Black Earth of Russia, and A. P. Pavlow on Sandstone dikes.

Miss Ogilvie (Mrs. Gordon) gives some results of her researches on the Dolomites of the Tyrol. Marr treats of the Skiddaw Slates, C. A. Matley of the Arenig rocks, while W. Gibson deals with the Palæozoic rocks of South Africa.

The fossils discovered by Hicks in what were regarded as the unfossiliferous Morte Slates receive attention, and Howard Fox records new localities for fossils in the Devonian of Cornwall. Wheelton Hind discourses on the Yoredale Series, and W. Gunn on the Lower Carboniferous rocks of northern England and Scotland.

The age of the Wealden, whether Jurassic or Cretaceous, comes under discussion. The Chloritic Marl and Warminster Greensand are dealt with by Meyer and Jukes-Browne, and interesting notes are given of the Cretaceous fossils from the Drift of Aberdeen. An important paper on the structure of Creechbarrow, in Dorset, is contributed by Hudleston, who shows that this remarkably prominent hill owes its preservation to the occurrence of an Eocene or possibly Oligocene limestone.

The origin of erratic blocks in the Drift of Yorkshire leads to an amusing correspondence between Howorth and Harker, in part relating to the supposed carrying of stones by the Vikings. Many pages of the Magazine are occupied by Howorth in essays on the Surface Geology of North Europe, on the Scandinavian Ice-sheet, on recent changes of level, and on the Glacial Drifts of Eastern England, the power of water *versus* ice being dwelt upon; while Dugald Bell writes on the question of submergence during the Great Ice Age. R. M. Deeley and G. Fletcher deal with the Structure of Glacier Ice, and Mr. E. P. Culverwell contributes an important article on the Theory of the Ice Age.

The glacial phenomena and denudation of the Skye mountains are dealt with by Harker, who has spent many field-seasons in this grand region. Howorth, writing on the Earliest Traces of Man, rouses up some discussion on Kent's Cavern and Buckland, while Mr. S. H. Warren contributes a suggestive paper on the relative age of Stone Implements, and the Rev. R. A. Bullen deals with Eoliths. Scharff describes the caves of county Sligo. The subject of Dene-holes comes in for discussion.

An interesting essay is contributed by H. W. Pearson on Oscillations of Sea-level, and Holst deals with Oscillations of land during the Glacial period in Scandinavia. In connection with this subject Hull's paper on the Submerged Platform of Western Europe roused up discussion by J. W. Spencer and Jukes-Browne, and led to an important essay by Hudleston on the Eastern Margin of the North Atlantic Basin.

The determination of the pre-Glacial age of the raised beach in Gower by R. H. Tiddeman finds interesting support elsewhere in the similar sequence of deposits off Cork Harbour, quite lately described by H. B. Muff and W. B. Wright.

River development attracts much attention, and S. S. Buckman leaves his Ammonites and his 'Hemera' to take part in the discussion. The subject was introduced in a paper on Bala Lake and river system by Philip Lake, and Callaway contributes articles on the general question, while W. M. Davis writes on the peneplain of the Scottish Highlands and discusses the meanders of rivers.

The ancient glacier-dammed lakes of the Cheviots are described by Kendall and Muff, while Bonney writes on moraines and mud-streams in the Alps. Parkinson discusses the origin of certain Canadian Lake-basins. Rock-basins, indeed, come in for considerable notice.

Watts deals with the ancient rocks of Charnwood Forest and their physiography, and Mellard Reade continues to discourse on mountains.

Among general papers those by Cowper Reed on the Geology of Waterford, and by Beadnell, Barron, and Hume on Egypt, may be mentioned.

Our old friend Rupert Jones gives a full History of Sarsens.

The subject of Geological Photographs is brought prominently into notice by Watts, and a number of excellent examples are reproduced. Judd gives an interesting history of the earlier British geological maps.

Finally, much attention is again given to Geological Time, the question having been considered by Joly in reference to the circulation of salt. Sir A. Geikie deals generally with the subject in his address to the British Association.

Turning to the topics that are occupying much attention at the present day, we find that the chief discussions are on subjects somewhat similar to those mentioned by Professor Rupert Jones in the first number of the Magazine. The origin of the crystalline schists, the genesis of rivers and the formation of their valleys, the excavation of lake-basins, the correlation of strata by means of special assemblages or zones of fossils, and the evolution of species are subjects which engage continued attention and upon which much has yet to be learnt.

Throughout the history of the Magazine, now one topic, now another has become dominant for a time. The relative importance of marine and subaërial denudation, the origin and development of rivers, the formation of crush-conglomerates, and the subject of dynamic metamorphism are instances. But if these subjects have again and again been brought forward, it is because someone gives the key to what was previously an enigma, and many are ready to use it; or another has gained a position from which a clearer view of a subject has been gained. From every fresh summit our ideas of the expanse of unacquired knowledge are constantly enlarged—a statement which is well known to apply to every branch of learning—and this being the case there is a constant demand for careful, earnest observers and workers, and there should be a constant demand for the GEOLOGICAL MAGAZINE.

(*To be continued.*)

Cupressinoxylon hookeri, sp. nov.,
a large silicified tree from Tasmania, preserved in the Geological Department, British Museum (Natural History).

II.—*Cupressinoxylon hookeri*, sp. nov., a large Silicified Tree from Tasmania.

By E. A. Newell Arber, M.A., F.L.S., F.G.S., Trinity College, Cambridge University Demonstrator in Palæobotany.

(PLATE I.)

ONE of the most striking objects exhibited in the Gallery of Fossil Plant remains in the Geological Department of the British Museum (Natural History) is a large trunk of a Coniferous tree from Tasmania, of which a photograph is reproduced on Plate I. This specimen[1] is one of the largest in the gallery, being nearly nine feet in height, and three feet in diameter. The woody tissues are in excellent preservation, the specimen being silicified, and in part opalized.

The history of this tree is an interesting one. It was discovered, apparently early in the last century, on the estate of a Mr. Richard Barker at Macquarie Plains, New Norfolk, Tasmania. When found, the tree was embedded in an upright position in a basaltic lava. Although silicified wood is of common occurrence in that neighbourhood, the large size of the trunk—the specimen being then at least three feet longer than at present—appears to have created general interest. Among others, Sir Joseph (then Mr.) Hooker, while on a voyage of discovery in the Southern seas in H.M.S. "Erebus," visited the locality to examine this fossil. Sir Joseph Hooker[2] contributed a most interesting description of the specimen to the first volume of the Tasmanian Journal of Natural Science, published in 1842, from which the following quotation is taken:—"One of the most remarkable circumstances connected both with the Geology and Botany of Tasmania, is the occurrence of vast quantities of silicified wood, either exposed on the plains, or imbedded in rocks both of igneous and aqueous formations. Those of the former, in particular, are the most striking, from their singular beauty, and the very perfect manner in which the structure of the living wood is retained. Soon after my arrival in this Colony, magnificent specimens of a fossil tree were shown me, dug out of a volcanic rock, and which, as far as my memory serves me, were unequalled even in what I had seen of the rich collection of Brown."[3]

A few years later the tree was brought to England and exhibited in the Tasmanian Court of the Great Exhibition of 1851.[4] At the close of the Exhibition it was presented to the British Museum by the Tasmanian Commissioners, but owing to the large size of the

[1] Registered number, V. 332. A smaller specimen (V. 9,606) of a similar tree from the same locality is exhibited side by side with that described here.

[2] Hooker: Tasmanian Journ. Nat. Sci., vol. i (1842), p. 24.

[3] Robert Brown (1773–1858), first Keeper of Botany at the British Museum, gathered together a large collection of petrified woods from different parts of the world. Most of these specimens are now incorporated with the plant collections in the Geological Department of the British Museum.

[4] Official Catalogue, Great Exhibition of the Works of Industry of all Nations, 1851, vol. ii, p. 999 (No. 348).

specimen and the crowded nature of the Natural History exhibits, then at Bloomsbury, it was not possible to exhibit it until their removal to the more suitable and spacious quarters at South Kensington had been completed.

From the geological standpoint, this tree is especially interesting in the manner of its occurrence. The Basalts of the Macquarie Plains are of Tertiary age, but there seems to be some difference of opinion as to whether they belong to the earlier[1] or later[2] period. McLachlan's[3] description of this specimen states that the tree "was imbedded in lava, and distinctly surrounded by two flows of scoria."

The association of plant remains with volcanic outpourings, especially with the more basic tuffs and lavas, is by no means of rare occurrence. Excellent illustrations may be found in the rocks of this country. In the Tertiary leaf-beds of Mull,[4] well-preserved impressions of leaves, similar to *Platanus* and other recent genera, occur in gravels closely associated with sheets of basaltic lava. Calcified stems and other fragments of plants of the greatest botanical importance have been discovered in beds of volcanic ash in the Lower Carboniferous rocks of Petticur, near Burntisland, and at Laggan Bay in the island of Arran.[5] Silicified stems in association with basalts and other igneous rocks are known from many parts of the world, especially from South America, where their occurrence has been described by Darwin.[6]

The vertical position in which the tree was found is emphasized by Hooker and by McLachlan. It would be of some interest to know whether this trunk once formed part of a forest which, at some period or other, was overwhelmed by showers of ashes and lava-flows. On this point there is, however, little information. McLachlan suggests that the vertical position is more or less accidental, and states that the base of the tree was embedded in sand.

The tree, as it stands now, is decorticated, only the woody tissues being seen. The outer portion is opalized and fairly hard, but the more internal tissues crumble away to a fine white powder at the slightest touch. This powder consists of the isolated woody fibres of the stem. Sir Joseph Hooker has so graphically described the condition and structure of the specimen that I cannot do better than quote his remarks.[7] "The bark (?) is of a different colour and more consolidated than the interior, resembling the most beautiful agate. The woody part reminded me of the lignite, so common in Lough Neagh, in the north of Ireland. . . . . The most remarkable circumstance, however, connected with this fossilized tree, is the manner in which the outer layers of wood, when exposed by the

[1] Johnston: "Geology of Tasmania," 1888, pp. 215 (table) and 294.
[2] Stephens: Papers and Proc. Roy. Soc. Tasmania for 1897, p. 54 (1898).
[3] See note 4, previous page.
[4] Starkie Gardner: Q.J.G.S., vol. xliii (1887), p. 270.
[5] Wünsch, Trans. Geol. Soc. Glasgow, vol. ii (1865), p. 97; and Bryce, "The Geology of Arran," 4th ed. (1872), p. 123.
[6] Darwin: "Geological Observations," 2nd ed. (1876), p. 394, etc.
[7] Hooker: ibid., p. 25.

removal of the bark, separate into the ultimate fibres of which it is composed, forming an amianthus-like mass on the ventricle of the stump in one place, and covering the ground with a white powder, commonly called here native pounce. The examination of a single concentric layer from this part shows that it may be detached from the contiguous layers of the preceding and following years' growth; there being no silicious matter infiltrated into the intervening spaces. A portion of each layer is found to have a second cleavage, not concentric with it, but in the direction of its radius, or of a line drawn from the centre to the bark of the tree. Such a cleavage is to be expected from the fact, that it is in the direction of the medullary rays that traverse every where the woody tissue. Each of these laminæ is of extreme tenuity, of indeterminate length, and of the breadth of the layers of wood; and is formed of a single series of parallel woody fibres, crossed here and there by the cellular tissue of the medullary rays, which do not generally interfere with their regularity. These plates, again, are separable into single minute fibres, which are elongated tubes of pleurenchyma or woody tissue, tapering at either end into conical terminations of indefinite length. They lie together in such close approximation that the microscope does not detect an interstice, though the least force separates them."

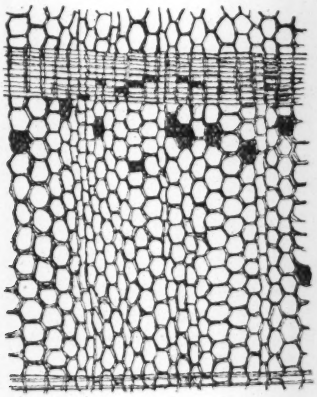


Fig. 1

FIG. 1.—*Cupressinoxylon hookeri*, sp. nov. Transverse section, × 100.

Sir Joseph Hooker concluded that the tree was undoubtedly Coniferous, as could be ascertained by a microscopic examination of the isolated fibres, without the preparation of sections. It may be interesting in these days, when microscopic sections are a constant necessity to those who are working on the subject of fossil plants, and readily obtained at a cost of a few shillings, to quote a further sentence of Sir Joseph Hooker's description, as illustrating the

progress in this respect during the last sixty years. He says, "Such slices have hitherto only been prepared by the most skilful lapidary, and at great cost."[1]

Sections of the harder parts of the tree have recently been made with the object of determining, if possible, the group of Coniferæ to which this specimen belongs. The preservation is exceedingly beautiful, the pits on the walls of the woody elements being well preserved.

The conclusion arrived at from an examination of these sections is that the woody tissues of the tree possess a structure of the type known as *Cupressinoxylon*, Goepp. As this species has not, apparently, been named hitherto, I propose to call it *Cupressinoxylon hookeri*, in honour of the great Botanist whose description of this specimen formed one of his earliest scientific contributions.

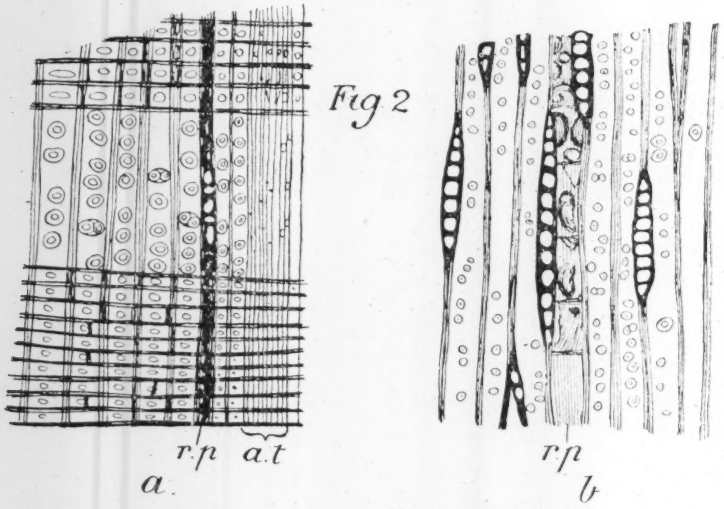


FIG. 2.—*Cupressinoxylon hookeri*, sp. nov.

(*a*) Radial longitudinal section showing the medullary rays with simple pits, and spring tracheides with bordered pits. *r.p.* resin parenchyma; *a.t.* tracheides of autumn wood. ×200 (slightly restored).

(*b*) Tangential longitudinal section. *r.p.* resin parenchyma. ×200.

It has been long known that it is not possible to refer coniferous woods, by a study of the anatomy of stems, whether recent or fossil, to genera based on the natural affinities of such plants. This was first clearly pointed out by Goeppert[2] in his treatises on the structure of living and fossil Coniferæ published in 1841 and 1850. Several recent genera belonging to such widely different families as Cupressaceæ, Abietaceæ, and Taxoidiaceæ, possess a woody structure

[1] Hooker: ibid., p. 26.

[2] Goeppert: "De Coniferarum, structura anatomica," Breslau, 1841; and "Monograph der fossilen Coniferen," Leiden, 1850.

closely similar to that of the Tasmanian tree, and such woods are usually included in the form-genus *Cupressinoxylon*.[1]

In *Cupressinoxylon* the annular rings are well marked. The bordered pits of the tracheides are separate, usually uniseriate; when biseriate the pits are opposite one another. Resin canals are absent, but resin parenchyma is abundant.

Cupressinoxylon hookeri, sp. nov., may be recognized by the following characters. A tree more than 12 feet high, and 3 feet in diameter. Only the woody tissues are known. Annular rings distinct; the 'autumn tracheides' being markedly narrower than the 'spring' elements. Rings narrow, varying somewhat in size, but averaging about ·7 mm. in width. 'Summer wood' containing about 15 elements on an average in the ray. 'Autumn wood' with 4 to 9 or more elements; dense. Tracheides of considerable length, with uniseriate bordered pits on the radial walls, and often also on the tangential walls. The pits on the latter are sometimes smaller than those on the radial walls. Occasionally the pits are biseriate, and then the two pits are always opposite. Medullary rays numerous, composed of similar elements, uniseriate or occasionally biseriate, 3 to 14 or more cells in height. The medullary rays communicate with the tracheides, usually by a small simple pit on the radial walls. Occasionally in large medullary ray cells more than one pit occurs. Resin parenchyma, consisting of continuous rows of thin-walled cells, frequent, especially in the younger elements of the 'spring wood' and in the 'autumn wood.' Usually only one resin cell in each ray of the annular ring.

This type of woody stem is known from rocks of Jurassic age onwards, and is especially abundant in the Tertiary period. Perhaps the species which is known in most detail is that described very thoroughly a few years ago by Mr. Barber[2] from the Lower Greensand of Shanklin in the Isle of Wight, under the name of *Cupressinoxylon vectense*. Numerous species have also been described by Knowlton from the Potomac series (Neocomian) of North America, and many others are known from the Tertiary rocks of Europe, North America, and elsewhere. Conifers possessing this type of woody structure are abundantly represented in Australasia at the present time by such genera as *Podocarpus* and *Dacrydium*, both of which occur in Tasmania.

I wish to express my indebtedness to Dr. Smith Woodward, F.R.S., Keeper of the Geological Department, for permission to describe this interesting fossil, and for having sections prepared for the examination of its structure. I am also indebted to Dr. Henry Woodward, F.R.S., for having suggested to me an inquiry into the history and nature of the specimen described here.

[1] The grouping together of coniferous woods by their anatomical characters is fully dealt with by Schenk in Zittel's "Traité de Paléontologie," pt. ii, Paléophytologie, 1891, p. 838.

[2] Barber: "Annals of Botany," vol. xii (1898), p. 329.

III.—Remarkable Examples of Atmospheric Erosion of Rocks in Corsica.

By F. F. Tuckett, F.R.G.S.

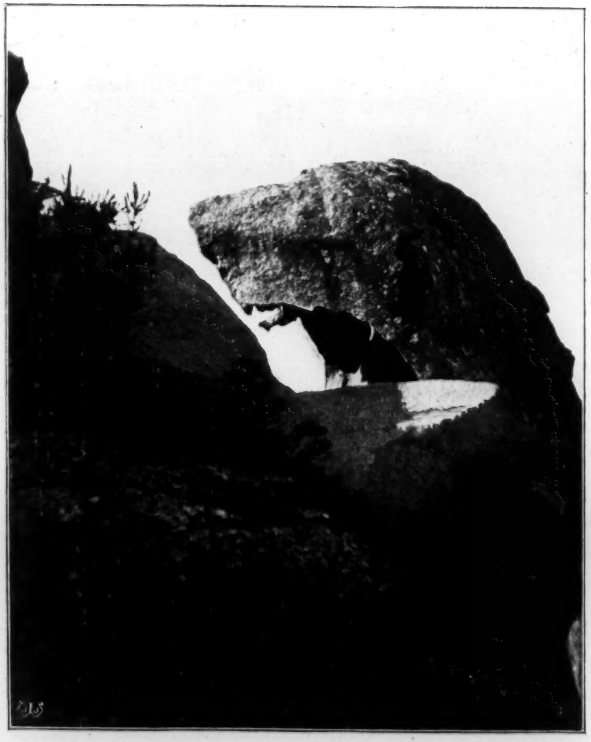
(PLATE II.)

In the course of repeated visits to Corsica I have been much struck by the extraordinary erosion, not only of cliffs, but even more so of detached masses or boulders, from near sea-level to heights of 5,000 to 6,000 feet; and, having taken some photographs last January of specimens of the kind last referred to, I sent them to my friend Professor Bonney, who informed me that he had never met with any instances of erosion of such a peculiar and unusual character, and asked whether I could furnish him with a fragment of the rock.

Unfortunately, owing to the inaccessibility of two of the objects photographed, and my hesitation to break away any of the third ("Tête de Chien"), I was only able to send him a piece obtained from a cliff by the roadside at some distance, which had been scooped out by erosion into overhanging eaves and other curious forms; and his report on this, after having a microscopic section prepared from it, was as follows:—

"The specimen is about 4½ in. long, 2 in. wide, and 1 in. in maximum thickness, weathered on both sides and on the blunter edge, apparently having been broken from a thin, flake-like projection such as would form the edge of one of the peculiar cavities in the photograph. The weathered surface is irregular, lumpy, and inclining to be flaky, of a dull dark-brown colour in the less prominent parts, elsewhere a pale brownish-green. The rock itself, quite close to the exterior, is a rather pale greenish-grey colour, somewhat mottled with small whiter and one or two darker patches, showing elsewhere a fibrous structure.

"Microscopic examination of a slice cut from one end, transverse to the length of the flake, proves the rock to consist largely of microlithic minerals, and to have been greatly affected by pressure—probably almost crushed. It exhibits two or three small grains of rhombic pyroxene, probably bastite; a number of small grains of augite, probably residual; a large quantity of rather minute actinolite, and perhaps a few flakes of a greenish to white mica. Some small grains, however, of a colourless, slightly flaky mineral, like bastite, but with oblique extinction, are certainly secondary, occurring somewhat after the manner of albite in certain crushed Alpine schists. Brown iron oxide is present only as an occasional staining or in granules, and sphene (possibly) in the latter condition. The rock has undergone so much secondary change that its original condition has been obliterated. I think it most probably has been a pyroxenite, with a little enstatite and possibly a few grains of olivine, allied to, but hardly to be classified with, the peridotites. It reminds me a little of some of the augite-serpentines of the Valais Alps, but in it actinolite practically takes the place of the mineral serpentine."



1. Hollow eroded dome, "Tête de Chien" (8–10 feet long). 2. Hollow eroded dome, in stream near Porto. "Le Calanche," near Piana, west coast of Corsica.

I may add that the first specimen I saw during an ascent of Monte Rotondo was a huge boulder, or *bloc perché*, perhaps 12 to 15 feet in diameter, at a height of 5,000 to 6,000 feet on a narrow spur of the peak, the interior of which reminded me of an ant's nest in an old oak beam, and so completely was it honeycombed that I was able to penetrate into the heart of the mass, where I was practically invisible to my companion.

Can any geologist suggest a cause for this extraordinary and, both in altitude and area, widely distributed erosion? It can hardly be decomposition, for, in the specimen described above, the rock seems in good condition just beneath the outer surface, and, at any rate in some instances, the situation appears to make the action of sand very improbable. Neither Professor Bonney nor I have seen anything in the Alps at all comparable to it, nor remember to have read a description of its occurrence in other places.

Note.—Since writing the foregoing my attention has been drawn, through the kindness of the Editor and of Dr. C. I. Forsyth Major, F.Z.S., to a passage at pp. 127–128 of "La Corse," by M. Ardouin-Dumazet, forming the 14th series of a "Voyage en France." This writer very accurately and pictorially describes the extraordinary weathering or erosion of the 'Red Granite,' or granitoid rocks of the Calanche, but only briefly alludes to the hollowed out, bomb-like forms specially referred to by me, if indeed they may be recognized in the phrase "La forme la plus générale de ces bizarreries est un évidement en forme de niches." He also speaks of "Des silhouettes d'animaux fantastiques."

As already stated, the rock from which my specimen was taken, instead of on the spot as it ought to have been, was at some distance to the south-west of the limited region of the Calanche, and, though much eroded or undercut, was probably of a different geological character from the sometimes almost spherical, bomb-like blocks such as that in the stream near Porto. I am inclined to think that the Calanche themselves are a rose or brick-coloured granite, as the writer just quoted and Joanne's "Guide en Corse" state them to be.

EXPLANATION OF PLATE II.

Fig. 1.—Eroded dome, "Tête de Chien" (8 to 10 feet long), "Le Calanche," near Piana, west coast of Corsica.

Fig. 2.—Eroded boulder in stream near Porto, west coast of Corsica.

IV.—Note on the Keratophyres of the Breidden and Berwyn Hills.

By H. Stanley Jevons, M.A., F.G.S., Lecturer in Mineralogy and Demonstrator in Geology in the University of Sydney.

It may be of interest to note the occurrence of a somewhat rare and interesting rock, named *keratophyre*, at two easily accessible localities in a district where it has been hitherto unknown—at Moel-y-Golfa, in the Breidden Hills, and in the Berwyn Hills.

The Breidden Hills.

Moel-y-Golfa was visited by me in 1899, and I collected a few specimens, which, however, remained unexamined until a few days

ago when I needed one for teaching purposes.[1] On examination of a thin section the plagioclase proved to be *albite*, idiomorphic and tabular in form, set in a matrix of chloritic decomposition products, doubtless the remains of pyroxene. The ratio of albite to pyroxene must have been about two or three to one. This composition is sufficient to place the rock in the keratophyre group,[2] but confirmation was obtained by comparison with a slide of the well-known keratophyre of Hüttenrode, in the Harz, the rocks proving almost identical both in structure and composition. The determination of the felspar was made by Becke's bright line method, which proved its refractive index to be everywhere slightly lower than that of balsam.

The igneous rocks of the Breidden Hills have been ably described by Professor W. W. Watts,[3] but I am not aware of any later reference to them. He believed the rocks of Moel-y-Golfa to be mostly lavas, and their plagioclases to be probably labradorite, and therefore named them andesites. His failure to recognise albite is to be attributed solely to the want of the refinements of petrographical investigation which exist to-day, Becke's bright line method having been known only since 1893.

The intrusive rocks of the Breiddens, described by Professor Watts as the 'Newer Series' of igneous rocks, and named by him diabases, may prove to be keratophyres when their felspars are closely examined. I have unfortunately no specimens available. The specific gravities quoted by Professor Watts are of little use as a guide owing to the decomposed condition of the rocks. Should they turn out to be dolerites (diabases), we should have another example of the interesting association of keratophyres with dolerites noted by Rosenbusch.[4]

The Berwyn Hills.

Since 1897 I have been from time to time engaged in investigating the igneous rocks of the Berwyn Hills, which lie to the south of the Dee Valley, between Corwen and Llandrillo. The igneous mass occupying the highest stratigraphical position is a series of quartz-keratophyre (soda-rhyolite) tuffs, with a lava of the same composition at its base. The fact that sections across the tuffs a mile or less apart invariably show different successions of quartz-keratophyre tuffs, the latter being distinguished from one another by colour and slight corresponding differences in composition, points to a large number of centres of eruption as their source. One of these lay near Blaen Llynor, as shown by the agglomerate to be seen in the bed of that stream.

The four great sills marked 'greenstone' on the Geological Survey Map of the district, together with their associated dykes

[1] The two specimens available are labelled:—568, Crags N. of Ty-bryn Farm, N. of Moel-y-Golfa summit; 572*a*, S. of road between "Plough and Harrow" and Trewern Farm, S. of Moel-y-Golfa.

[2] See definition, Rosenbusch, "Elemente der Gesteinslehre," 2nd ed., 1901, p. 287.

[3] Q.J.G.S., vol. xli (1885), p. 532.

[4] "Elem. d. Gesteinslehre," 1901, p. 288.

to be seen on the cliff above Llyn Llyne-caws, were found to have the composition of a keratophyre;[1] that is to say, they are essentially composed of *albite* and *diopside*. The proportion of diopside to albite was found to vary somewhat, and to be generally greater than in the case of the keratophyre of the Breiddens. Other minerals rarely make up as much as 10 per cent. of the rock. The texture is never porphyritic, and is generally that characteristic of the dolerites (diabases), from which these keratophyres are only to be distinguished by the refractive index or extinction angles of their felspars. As I believe this to be the first description of keratophyre as an intrusive rock, I may state that in this case there can be no question as to its intrusive character. The slates are distinctly metamorphosed above and below each sheet, the spotted slate so well exposed above having been mistaken for tuffs in 1850 by officers of the Geological Survey. The crag on Carnedd-y-Ci shows the hanging wall rent and penetrated by minute tongues of the igneous rock, and fragments of the sedimentary rock have been floated off into the magma.

No dolerites of the keratophyre facies (i.e. containing diopside) occur in the Berwyn district so far as I have been able to discover. The only basic rock in the neighbourhood is an olivine-dolerite with titaniferous augite forming a dyke trending north-west and south-east in Nant Llwyn Gwern, near Craig Wen. This is erroneously mapped as a triangular patch on the Survey Map, but is simply a coarse-grained dyke, probably to be connected with the Post-Carboniferous dykes of Anglesey and Carnarvonshire.

General.

The superficial resemblance of the intrusive keratophyres here described to the dolerites (diabases) so common in Carnarvonshire may be regarded as a significant fact. The felspars of the latter rocks have in a few instances been determined,[2] and were found to belong generally to the andesine-labradorite series. Albite has not been recorded. I would suggest that an interesting field of research lies open to some one more favourably situated than myself in determining the felspars of a large number of the Welsh pre-Carboniferous dolerite intrusions. Should albite be proved present in Carnarvonshire, we should have the association of keratophyres and dolerites confirmed, and it would be interesting to discover whether there was a passage between the two rocks, and, if so, whether horizontally or vertically. On the other hand, should albite be absent in Carnarvonshire, the existence of a series of rocks all of the same facies, basic in the north-west but acid in the south-east, would have to be explained.

A complete petrographical description of the rocks mentioned in this note is in hand, and will be published in another place as soon

[1] Thin sections of some 60 specimens taken from various parts of these masses have been examined.

[2] Harker: Q.J.G.S., vol. xliv (1888), p. 449; and "Bala Volcanic Series of Carnarvonshire," p. 81, Cambridge, 1889.

as the pressure of other duties permits. I would like to add that my work in the Berwyn Hills was assisted by a grant from the Government Grant Committee of the Royal Society.

Appendix.

Confirmation of the determination of the felspars in the keratophyre of Moel-y-Golfa was obtained by uncovering a portion of one of the slides and immersing the thoroughly cleaned edge of the section in ethylene bromide ($\mu = 1{\cdot}5355$, by the Fuess Refractometer, Model II). The felspar showed γ a little above μ of the liquid, α distinctly below. The extinction angles on sections perpendicular to 010 of twins on the albite and carlsbad laws also confirmed albite, the measurements on four sections being:—[20 : 22] [18 : 21]; [17 : 16] [17 : 21]; [9½ : 9½] [13 : 16]; [5 : 6] [3 : 3]. The determination of the felspar of the Berwyn keratophyre was also confirmed by refractive index measurements, and extinction angles on cleavage chips as well as on symmetrical sections twinned on the albite and carlsbad laws.

Brief descriptions of Becke's bright line method of determining small differences of refractive index, and of Michel Levy's method of determining the plagioclase felspars by the extinction angles on sections perpendicular to 010 of crystals twinned on both albite and carlsbad laws, will be found in the Appendix to Iddings' Translation of Rosenbusch's "Microscopical Physiography of the Rock-making Minerals," 4th ed., New York, 1900.

V.—Contributions to the Geology of Ceylon:
II. Silicification of Crystalline Limestones.

By A. K. Coomáraswámy, B.Sc., F.L.S., F.G.S., Director of the Mineral Survey of Ceylon.

THE occurrence of small quantities of chert and opal, usually in or near exposures of crystalline limestone, but very often in fragments or boulders not quite *in situ*, is not unusual in Ceylon. For some time the origin of these siliceous rocks remained obscure; observations made within the present year (1903), however, enable me to give a more detailed account of their mode of occurrence. I have had the advantage of my colleague Mr. James Parsons' company in examining many of the exposures, and have been able to discuss with him the problems raised.

A band of chert occurs *in situ* on the path descending from the ambalam just ¼ mile W.N.W. of Uduwela trigonometrical station (about 3 miles south-east of Kandy), and about 4 to 5 yards below the fourth of the six bands of limestone which are crossed in descending the hill.[1] The width of the band of chert is about 5 feet; it includes a number of varieties, all with good conchoidal fracture. These are: homogeneous green opal; homogeneous brown chert

[1] The locality can be identified on the map, Q.J.G.S., vol. lviii (1902), pl. xiii, but the position of the bands of limestone is not correctly indicated there.

(these two with very smooth fracture); brown mottled chert, with phlogopite, spinel, and graphite; green chert, with abundant mica and graphite, and less frequent spinel; and whitish decomposed chert, with the same accessory minerals in addition to blue apatite.

Specimens of limestone with identical accessory minerals occur quite near. On its north side, the chert band appears to pass into decomposed limestone which shows green spots suggestive of partial silicification. It was not quite certain that these apparent transition types occurred *in situ*. There were, however, many specimens which could only with difficulty be definitely named as chert or limestone. A thinner band of brown chert occurs on the path a little below the main band.

Partially silicified crystalline limestone. × 22.
C, carbonate (dolomite); M, mica; S, spinel; remainder, opaline silica.

Five thin sections of these cherts were prepared. One of the green opal (1056) shows merely a green, structureless, homogeneous, isotropic rock. The brown chert (1052) consists of chalcedonic silica, in characteristic spherulitic aggregates; there is a colourless transparent base in which are scattered very numerous tiny ferruginous aggregates which give the brown colour to the whole rock. Certain cracks are filled with characteristic chalcedonic infiltrations. Rounded spots containing fewer of the ferruginous specks, and appearing rather dark between crossed nicols, call to mind the appearance presented by structureless radiolarian casts; the presence of radiolaria is, however, quite out of the question. The greenish micaceous chert (1055) consists of opaline and chalcedonic silica in roughly equal proportions, enclosing numerous individuals of well-preserved phlogopite and a flake of graphite. In another, very similar specimen (1054) the mica is much hydrated, and silica has been deposited between the laminæ, which are swollen and displaced. In the mottled chert (1053) chalcedonic chert is much more abundant than chalcedony, and the accessory minerals include graphite and abundant and characteristic spinel, colourless in the

thin section but pink in the hand specimen. In none of these slides are any remains of carbonates to be found.

Some specimens collected from blocks resting on crystalline limestone, but not quite *in sitû*, on Upper Rajawela estate (about 11 miles from Kandy on the Teldeniya road), about a third of a mile E.S.E. of Rajawela trigonometrical station, were also sliced. Of these one (1074) evidently consisted of partially silicified limestone; the section showed disintegrated and corroded crystals of dolomite embedded in an isotropic siliceous matrix, in which an abundance of hydrated phlogopite and a few grains of spinel are also found.

The silica has penetrated along the cleavage cracks of the carbonates, with every appearance of corrosion. The dolomite individuals are thus broken up into irregular fragments, often more or less rhombohedral, and these graduate into the smallest specks which remain scattered in the siliceous base, sometimes indicating by their disposition the rough outline of the original carbonate.

Another specimen (1073) from this locality consisted entirely of brown chert and resembled No. 1053.

The amount of chert present in any locality is always small, and quite insignificant in comparison with the total amount of crystalline limestone present; nor can the occurrences of chert be followed for any distance. They are also met with in other parts of Ceylon, e.g. in the Uva Province, although their connection with crystalline limestone is not always traceable; but there is no direct evidence of their occurrence as a replacement of any other rock.

From the foregoing observations I conclude that these opaline cherts result from the alteration of crystalline limestone, the carbonates being dissolved and replaced by opaline or chalcedonic silica, or a combination of the two. Very possibly the pure siliceous rocks, free from accessory minerals, do not so directly replace the limestone, but are siliceous deposits similar to the chalcedony deposited in cracks in the other cherts, which must already have had time to harden and develop cracks, previous to the introduction of a further supply of silica. The silicification is probably the result of the presence of heated waters containing silica in solution introduced after the consolidation of the crystalline limestone in its present form. In other words we have here a metasomatic transformation. A number of hot springs are known to occur in Ceylon, e.g., at Badulla, Alupota, Bubule, and Bibile, in the Uva Province[1]; and near Koggala, Magam Pattu, in the Southern Province.[2] The occurrence of these springs lends support to the probability of such alterations having taken place.

It is of interest to notice the bearing of these observations on the origin of cherts in general[3]; we are here dealing with cherts which are certainly of inorganic origin. The mica, spinel, and graphite met with in the chert are proof that the original rock was a crystalline

[1] Uva Manual, by H. White, Colombo, 1903, p. 82.

[2] Ceylon Administration Reports, 1902, Survey Department, p. B. 30.

[3] For a discussion of this question, see C. A. Raisin, Proc. Geol. Assoc., xviii (1903), pp. 71–82.

limestone quite similar to those still met with in large quantity; no source of abundant silica can be found in these rocks, so that we are driven to conclude that it has been introduced from without. It is simplest to suppose that the silica was introduced in solution in the waters of hot springs. It may have been deposited at first in the colloid form and subsequently have become chalcedonic in parts; or the two forms of silica may have been deposited more or less simultaneously. It seems likely, however, that, at least to some extent, there has been a transformation from opal to chalcedony.

In conclusion, the cherts described represent a secondary condition of a rock originally different, viz. crystalline limestone; the silica has been introduced from without, and is of inorganic origin; the silica has been chemically deposited, chiefly in the colloid form, and replaces the carbonates which have been removed in solution.

VI.—On the Recent Tufaceous Deposit of Totland Bay, Isle of Wight.

By A. Santer Kennard and S. Hazzledine Warren, F.G.S.

On the top of the cliff between Headon Hill and Widdick Chine, in Totland Bay, there is a Recent tufaceous deposit containing land and fresh-water shells. It extends along the cliff for nearly 350 yards in a north-easterly direction from the base of Headon Hill, and is about 60 feet above the sea-level.

It was first described by Mr. Joshua Trimmer,[1] and subsequently by Professor Edward Forbes[2] and Mr. H. W. Bristow.[3] In the more recent memoir on the Isle of Wight[4] the earlier descriptions are quoted, but the section is described as being then almost entirely overgrown.

The deposit is described as being of very variable character, as the following details will show. At the base of Headon Hill Mr. Trimmer states that it presented the following section:—

		feet.
c.	Warp-drift: brown sandy loam without lamination, containing fragments of flint and Tertiary limestone. Filling furrows in the bed below	1 to 3
a–c.	Alternations of cream-coloured marl, calcareous tufa, and sand and clay blackened by organic matter; the calcareous tufa being in beds 6 inches to 2 feet thick, and the sand and clay forming bands of 2 to 6 inches in thickness	12 or more

This author also states that Professor Edward Forbes obtained shells of the genus *Unio* in a layer of flint gravel which occurs in places beneath the tufaceous deposit. Possibly this should be *Anodonta* rather than *Unio*, but no fresh specimens have been found to settle the point. Not far from the termination of the deposit

[1] Quart. Journ. Geol. Soc., 1854, vol. x, p. 53.

[2] "On the Tertiary Fluvio-Marine Formation of the Isle of Wight"; Mem. Geol. Survey, 1856, p. 8.

[3] Ibid., p. 105.

[4] "The Geology of the Isle of Wight," by Messrs. H. W. Bristow, Clement Reid, and Aubrey Strahan: Mem. Geol. Survey, 1889, p. 229.

(that is, as seen in the cliff section), in a north-easterly direction, or away from Headon Hill, Mr. Trimmer gives the section as follows :—

		ft.	ins.
e.	Warp-drift of brown loam	5	0
c.	Cream-coloured marl, with calcareous concretions, and a few thin black seams coloured by vegetable matter; land-shells	2	6
b.	Sand blackened by organic matter; calcareous concretions and land-shells	4 inches to 1	0
a.	Calcareous tufa; land-shells	10 inches to 2	0

In describing the calcareous concretions, Mr. Trimmer states that some are cylindrical and others sub-globular. The former have often a cavity through the middle, which is occasionally filled with decayed vegetable matter; thus showing them to have accumulated round the twigs and stems of plants, as their form suggests. He also considers that many of the sub-globular concretions may have had land-shells for their nuclei. This author records: *Helix* [= *Helicigona*] *arbustorum* or *nemoralis*; *Helix* [= *Hygromia*] *hispida*; *Cyclostoma elegans* [= *Pomatias reflexus*].

Professor Edward Forbes confirms Mr. Trimmer's account, and gives the following section, though without stating its exact position in the cliff section :—

		ft.	ins.
e.	Loam, with scattered Helices, fragments of flints ... ... *Helix* [= *Helicigona*] *arbustorum* or *nemoralis*, *Cyclostoma elegans* [= *Pomatias reflexus*], abundant.	6	0
d.	Clay-bed more full of shells. *Limnæa palustris*, *Helix* [= *Vallonia*] *pulchella*, *Helix ericetorum* [= *Helicella itala*], *Helix* [= *Hygromia*] *hispida*, *Zua* [= *Cochlicopa*] *lubrica*, *Achatina* [= *Cæcilianella*] *acicula*.		
c.	Bluish carbonaceous marl, shells most plentiful ... ... *Succinea oblonga*, *Cyclas*.	2	0
a–b.	White tufaceous marl, sandy in places, becoming purplish towards base, and somewhat stratified ... ... *Cyclostoma elegans* [= *Pomatias reflexus*], *Clausilia*, *Succinea oblonga*, *Cyclas* or *Pisidium*, *Helix hortensis*, *Helix* [= *Pyramidula*] *rotundata*, *Helix* [= *Vitrea*] *cellaria*.	3	8

Mr. H. W. Bristow describes the deposit generally as consisting of :—

c. Brown loam, of unequal thickness, with scattered angular flints.
d. Brown clay with perished shells.
a–c. Calcareous tufa, 4 to 5 feet thick, sometimes equalling the Limnæan limestone in hardness, finer at the top and coarser below, and with a few black lines caused by decayed vegetable matter.

Since these last-named authors examined the deposit for the memoir of 1856 on "The Tertiary Fluvio-Marine Formation of the Isle of Wight," no further information concerning it appears to have been obtained.

It was largely owing to a remark in a former paper[1] that one of us was led to collect from this deposit. Though the cliff was

[1] A. Santer Kennard and B. B. Woodward, "The Post-Pliocene Non-Marine Mollusca of the South of England": Proc. Geol. Assoc., 1901, vol. xvii, p. 231.

found to be overgrown, but little difficulty was experienced in finding a place where the turf had slipped so as to expose the calcareous tufa beneath. Nothing, however, was seen of any of the beds of clay or sand associated with it. The spot from which the present collection was taken was at a very short distance to the south-west of Widdick Chine, and at about 8 or 10 feet below the top of the cliff. All the shells were obtained from about the same level, within a foot or so, but as no clear section was seen, and the bed collected from may have slipped somewhat from its original level, there is no reason to correlate it with one of the beds of tufa, as described by previous authors, rather than with another.

Seventeen species of mollusca were obtained, viz.:—

Vitrea crystallina (Müll.).
„ *nitidula* (Drap.).
„ *radiatula* (Alder).
Zonitoides nitidus (Müll.).
Euconulus fulvus (Müll.).
Sphyradium edentulum (Drap.).
Pyramidula rotundata (Müll.).
Helicigona arbustorum (Linné).
Helix nemoralis (Linné).
Helix hortensis (Müll.).
Cochlicopa lubrica (Müll.).
Jaminia muscorum (Linné).
Vertigo substriata (Jeff.).
„ *pusilla* (Müll.).
Clausilia bidentata (Ström.).
Carychium minimum (Müll.).
Limnæa truncatula (Müll.).

It will be noticed that only six of these species have been hitherto recorded, whilst several listed species did not occur in the material. Two species, *Vertigo substriata* and *V. pusilla*, are as yet unrecorded living from the Isle of Wight or Hampshire, though they are known to occur in tufaceous deposits in Hampshire. It is noteworthy that the examples of *Helix nemoralis* are without bands, whilst the specimens of *Helix hortensis* possess all the bands. Mr. Clement Reid, F.R.S., has noted that in the tufaceous deposit at Blashenwell a similar state of things occurred.[1] The great variation in these species is well known, and this variation is to be found amongst the fossil examples as well as recent, but with the shells from these two similar deposits there is no variation whatever. It affords an extremely interesting problem for which we can offer no solution.

The deposit lies on an uneven surface of the Potamomya Sands, which underlie the Limnæan limestone and belong to the Upper Headon Beds. Both Professor Edward Forbes and Mr. H. W. Bristow describe it as lacustrine, though land-shells are characteristic and fresh-water forms comparatively scarce, as had previously been noticed by Mr. Joshua Trimmer. Both the molluscan fauna and the nature and position of the deposit itself clearly indicate a damp land-surface, over which oozed the water, highly charged with carbonate of lime, which was thrown out of the Headon Hill limestones by springs. It is noteworthy, in this respect, that Mr. Trimmer describes it as being thickest under Headon Hill, and thinning away, and finally disappearing, in a distance of little more than

[1] C. Reid, "An Early Neolithic Kitchen Midden and Tufaceous Deposit at Blashenwell": Proc. Dorset Nat. Hist. and Ant. Field Club, 1896, vol. xvii, p. 74.

300 yards in a north-easterly direction. The springs to which this tufa owed its origin have been tapped by the recession of the cliffs,[1] so that no calcareous deposit now takes place, or has done since the deposition of the 'Warp-drift.' From the presence of a certain proportion of fresh-water forms, and from the beds of sand and clay which are interstratified with the tufa, there were most probably one or more small streams meandering through the area, with frequently changing course, but there does not appear to be any evidence of lacustrine conditions.

There can be no doubt that the deposit belongs to the Holocene Period, but no evidence has been obtained to enable us to fix its age with any greater precision.

VII.—The Ophite of Biarritz.

By P. W. Stuart-Menteath, Assoc. R. S. Mines.

FOUR articles in the Biarritz Association Bulletin, and a series in the last publications of the Soc. Géol. de France, discuss the problem of Pyrenean ophite by conjectures regarding the obscure points of greenstone in the shifting sands of the Biarritz coast. When first seeking new facts at Biarritz, I discovered the red marls and gypsum that accompany the ophite to be recurrent in the undisputed Upper Cretaceous of Croix d'Ahetze, and I followed the Biarritz rocks to Zumaya and Loyola in the attempt to trace their relations. Having subsequently proved that the other red clays mapped as Trias are brick clay of post-Glacial origin, contemporary with a tooth of *Elephas primigenius* and anterior to flint implements described as Pliocene, and having vainly demonstrated the continuity of the rocks of the Spanish coast by both maps and fossils, I would invite geologists to profit by the light railways and other advantages which to-day enable the fundamental section of Pyrenean geology to be easily studied in its unmistakable continuation.

Ideal constructions represent the Biarritz rocks as sharply truncated by an *effondrement* of the Atlantic basin. Observation proves that they skirt the coast, form the promontory of Abadia, present three species of Nummulites at Pasages, and, although stripped by the waves beyond Zumaya, recur in patches to far beyond Santander. The confusion resulting from treating as a transverse section the almost longitudinal exposures of Biarritz is an example of not uncommon tectonics.

The fossiliferous red limestones and marls which extend by Abadia and Fontarabia to Zumaya are rich in Ammonites, worked for cement, recognizable by lithologic character, and regularly affected by sharp local plications and dislocations along the thirty miles of coast in question. Marine erosion between Bidart and Abadia produces the only important break. Exactly as at Biarritz, so also at Fontarabia, the fossiliferous Danien summit of the Cretaceous is overlain by Flysch that represents the Lower Eocene and

[1] "The Geology of the Isle of Wight," by Messrs. H. W. Bristow, Clement Reid, and Aubrey Strahan: Mem. Geol. Survey, 1889, p. 229.

insensibly passes to the Nummulitic sandstones of the Biarritz cliffs. But at Fontarabia all formations are inclined at 15°, and the red and green clays that irregularly occur towards the junction of Eocene and Cretaceous are here, as along the whole thirty miles to Zumaya, obviously normal beds of Eocene or Cretaceous, whose vivid coloration and lithologic character explain these supposed intrusions of the Trias. The clearly local character of the sharp plications and dislocations is proved along thirty miles; the incorrectness of assuming the same to be gigantic faults at Biarritz is hence apparent. But many years ago I further urged the fact that the opposed dips and strikes, regularly quoted at Caseville as proof of a gigantic fault, are visibly local and gradually vanish towards the 'fault,'—which fault is moreover inferred logically from the erroneous supposition of Jacquot that its continuation at Fontarabia is indicated by a recurrence of Cretaceous, marked as such on every map except mine of Comptes Rendus Ac. Sc. of June, 1894, and that published in 1900 by the author of the Spanish Geol. Survey map of 1884. The Nummulites found at Pasages were recognized as unquestionable by Munier-Chalmas and other special authorities. As such decisive points are ignored in the entire discussion, and as the geologist who concludes it has classed the Flysch as Cenomanien by fossils at Gotein whose head and tail project on opposite sides of the decomposed limestone rolled pebbles that contain them, I need hardly discuss the siliceous *Orbitolina* which occur in the Flysch conglomerates, both beneath the Danien at Ciboure and above the Danien at Caseville, in rolled pebbles of that Cenomanien limestone whose outcrops to the south bristle with those indestructible organisms. From the central Pyrenees to the Ocean I have found *Hippurites, Plagiopticus*, and other shells of Turonien character in the uppermost beds of the Cenomanien limestone, which is the usual basis of the Flysch. My best collection of Turonien fossils is from the base of the Flysch of Roncesvalles and Oroz, which visibly overlies the Cenomanien limestone. M. Seunes discovered in my Cenomanien both Gault and Lower Aptien, respectively characterized by two names of one shell, found by both Sowerby and Davidson in the Cenomanien, but at first inadvertently christened with a name already monopolized by a Jurassic brachiopod.

South of Zumaya the red Danien and the Senonien of Bidart, largely worked at both places for cement, rest normally, as at Biarritz, on the Turonien Flysch. From beneath this rise irregular bosses of Cenomanien limestone, which, precisely as at Arette, Atheray, and many intermediate places, furnish a black and a flesh-coloured marble abounding in characteristic fossils. The polished slabs which line the sanctuary of Loyola, and are largely employed in the neighbourhood, present innumerable sections of *Radiolites Cantabricus*, Douvillé, *R. foliaceus*, Lamk., and other shells which, here as elsewhere, prove a Cenomanien age. In the recurrence of the Flysch above this limestone between Loyola and Zumarraga, I have counted fourteen intrusions of ophite in eight miles of the road. These intrusions, together with intermediate slices of usually

metamorphosed but often freshly marly Flysch, compose a mountain mass nine miles in length and 2,000 to 3,000 feet in height, whose central portion is solid, and is mapped as solid ophite by the Spanish Survey on a transverse diameter of over three miles. The several intrusions strike in the four directions which in 1886 I summarized from a detailed survey of the mineral lodes of the neighbouring Pyrenees. As these lodes are very certainly of Tertiary age, the ophitic intrusions indicate a similar origin. Here only crush and contact breccias are noticeable, and the intrusions are of every variety from typical ophite to typical melaphyre and highly vesicular spilites. The uniquely valuable investigations of Dr. Ogilvie Gordon are especially applicable to this case, which affords ample evidence touching the intrusive character of the Biarritz ophite and its independence of any special formation in spite of constant association with the peculiar *facies* of the Flysch.

East of Biarritz a mass of ophite four miles in diameter, between Anglet and Villefranque, resembles that of Loyola in cutting across the Upper Cretaceous beds, and in the freshly irruptive character which enables both to be largely employed for metalling roads. At the Villefranque salt-work the same Nummulitic species are in contact with the gypsum, salt, and ophite as are in similar contact on the Biarritz coast. At both points the rocks of the Lower Eocene are metamorphosed and dislocated as at other Pyrenean localities. The oldest rocks of the neighbourhood are those containing the abundant Greensand fauna which I discovered and described in 1887 in Bull. Soc. Geol. The subsequent maps and papers of Captain Gorceix (1894), being filled with new and decisive facts, are never quoted by those who best know them. The salt deposits of Villefranque are analogous to those of Cardona, Suria, Pinos, etc., whose obviously Eocene age has been doubted only in consequence of speculations regarding Biarritz.

The ophite of Loyola is connected with the similar mass adjoining Biarritz, not only by the coast rocks, but also by two bands of Upper Cretaceous which, constantly accompanied by numerous ophite intrusions, cut across all the rocks of the western Pyrenees. One runs between Tolosa and Cambo, the other between Tolosa and St. Jean Pied de Port. In indifferent contact with rocks of every age, these bands independently connect the Flysch of Loyola with that of Biarritz, and show the intimate relation of the ophites which I have mapped along their unsuspected course. They habitually skirt the Trias; but the Muschelkalk of that formation, which I have compared by fossils and lithologic character to that of Goslar, is constantly broken into three or four strips separated by ophite outcrops, whereas the Upper Cretaceous exhibits contemporary volcanic conglomerates containing fossiliferous fragments of every age. These conglomerates abound in the Cambo district, and are thence traceable to Biarritz, as habitual constituents of the Upper Cretaceous Flysch. In both the ophitic outcrops of Mouligna and Caseville the ophite is only visible as isolated blocks and fragments in the metamorphosed horizon between the Danien

and the Middle Eocene. Attempts to explain these outcrops as intrusions of Trias from below, or as carted caps from above, are equally opposed to the entire analogies of the neighbouring Pyrenees and to all serious observation of the ophites from the Pyrenees to Portugal, Italy, and Switzerland. They are hence instructive as explaining the paradoxes which their identical authors have each and all asserted regarding other districts of both the Alps and Pyrenees. I should add that the Spanish Survey maps, although fully recognizing my earlier observations, require considerable modification through those made since 1884, as their able authors would be the first to acknowledge.

VIII.—The Toarcian of Bredon Hill: A Reply to Prof. Hull.[1]

By S. S. Buckman, F.G.S.

IN criticising my paper Professor Hull "regrets very much to have found it necessary to make these remarks." I regret it too, because he only raises issues which have been discussed, and, I hoped, settled years ago. But I fear that Professor Hull has not given attention to modern Jurassic literature. He says that Midford Sands is "a name unknown to geologists in general." Whereas, as the Editor points out, Professor Phillips was the author who amused himself with inventing this fanciful name, to adopt my critic's language. And in the 1879 edition of Sheet 44, at the foot of which appears the name E. Hull, there is on the margin this legend, "G 4, Midford Sand."

With similar neglect of literature the Professor states that "the much-debated question" about the sands "*was* settled [in favour of the Lias] by Dr. Wright in 1856, and was accepted by the Geological Survey." Yet in the Survey memoirs, "The Jurassic Rocks of Britain," vols. iii, iv, 1893–94, the Midford Sands are grouped with the Lower Oolitic series. Sir A. Geikie says in his "Textbook of Geology," 3rd ed., p. 898: "The upper stage [of the Lias] is composed of clays and shales . . . . surmounted by sandy deposits, which are perhaps best classed with the Inferior Oolite"—the view adopted by most Jurassic geologists.

If my critic had read my paper carefully he would have seen that what I claim to have settled is quite different from what Dr. Wright did. That author considered the sands of the Cotteswolds, of Somerset, and of Dorset, to be all on the same horizon, a later deposit than the Upper Lias Clay, but with Liassic affinities. He had no idea that the sands of one district were actually *earlier in date* than the Upper Lias Clay elsewhere. Evidently, too, the Survey Officers had no idea that what they mapped as G 3 in Dorset was much later than what they called G 4 in Gloucestershire, and was the same horizon as some that was mapped G 5 in Somerset.

It is my discovery that "in different localities the Sands are of different dates" (Q.J.G.S., vol. lix, p. 456). It is my discovery

[1] Geol. Mag., Dec. IV, Vol. X, No. XII, p. 541.

exactly what Ammonite faunas are found in the sands of Somerset and Dorset, about which nothing precise was known a few years ago. It is my discovery that the Sands and Cephalopod Bed contain some half-dozen distinct Ammonite faunas, which maintain always the same sequence, now proved widely on the Continent. By this sequence I can date the different sands with precision, as I have done in p. 456 op. cit. This is largely against Wright's "discovery." He claimed all the sands as Lias. I am able, taking the arbitrary line which Wright himself accepted, to show that certain of "these various sands" are Lias, and others Oolite. I can claim to have settled the much-debated question, because I have been able to give the facts—the faunal sequence.

Professor Hull asks where I "got hold of the idea" about the comparative thickness of the Upper Lias at Wotton and Bredon. Not from Survey publications, he is positive. I quote from "Geol. Country around Cheltenham" (Mem. Geol. Surv., 1857, pp. 24, 25): "The Upper Lias Shale . . . at Leckhampton Hill . . . is 230 feet [in thickness] . . . At Cleeve Cloud . . . 300 . . . At Bredon Hill . . . 100 feet or more . . . Towards the south . . . it thins gradually away to Wotton-under-Edge, where it is about 10 feet thick." In Sheet 44, Geological Survey, the outcrop of Upper Lias is 300 feet, measured by the contour-map of the Ordnance Survey. H. B. Woodward says: "In Gloucestershire the Upper Lias varies from about 10 feet at Wotton-under-Edge, to about . . . . 380 feet at Bredon Hill."[1]

Professor Hull asserts that he knew "the sands [G 4] of Wotton with the clays below [G 3] were representative in time of the Upper Lias [G 3] of Bredon Hill." If this was his opinion, why did he not record it in his map? If the value of G 3 changes from place to place, it is not consistent mapping. If G 3 means G 3 at some localities, and G 3+G 4 at others, who is able to interpret the map?

A plea put forward during the discussion of my paper tried to justify the changing value of a symbol on the ground that it was the object of the Survey maps to record lithology for the guidance of agriculturalists. This seems to imply that the Survey maps were not intended to be geological documents, but merely charts showing the outcrop of the various clays, sands, or limestones. And if the benefit of agriculturalists was so much considered, why were the Vales of Evesham and Gloucester mapped as Lower Lias Clay, when nearly their whole surface is thickly covered with sands or gravels? What use is such a map to agriculturalists? I said that, for their good, the superficial deposits should have been mapped first. Professor Hull derides this idea: he implies that so much would be blank. He forgets that, in the few places where the solid rocks are not marked by technical 'drift,' from the farmers' and from a strictly scientific point of view the soil and subsoil are superficial deposits, whose varying phases are quite as capable of being mapped as anything else. There need have been no blanks.

[1] "Geology of England and Wales," 2nd ed., p. 276.

Professor Hull resents the suggestion that a map done fifty years ago naturally requires considerable modification. Yet that must be a truism. To admit it, allows one to offer cordial congratulation on the work accomplished. To deny it, is to claim superhuman infallibility, and to receive a rude awakening. For if the Professor had studied modern Jurassic literature he must have seen many cases where the facts show the boundaries on Sheet 44 incorrect—cases like the one just recorded by Mr. Richardson, that what is mapped as Inferior Oolite at Condicote, near Stow, is Great Oolite.[1] Then there are differences in interpretation. Advance in knowledge has shown that boundaries drawn by lithological characters cannot be maintained; that to a greater extent than was formerly anticipated, lithic change does not imply sequent deposits; that clay, sand, and limestone are but regional phases of contemporaneous deposition, not to be indicated, as formerly, by sequent symbols G 3, G 4, G 5, but to be marked by the same symbol with modificatory additions, say Ag., Ar., C. for Argillaceous, Arenaceous, Calcareous.

Professor Hull's remark about *ésprit de corps* is regrettable. When one meets Officials out of office hours, and especially at the rooms of the Geological Society, one expects to meet, not officials, but scientific men, who would not put the Survey first and scientific accuracy second, but who desire, above all else, the advancement of science.

IX.—Note on *Pericyclus fasciculatus*, F. M'Coy, sp.

By G. C. Crick, F.G.S., of the British Museum (Natural History).

In 1844, in his "Synopsis of the Carboniferous Fossils of Ireland," F. M'Coy described and figured the species *Goniatites fasciculatus* (p. 13, pl. ii, fig. 8), a Goniatite referable to the genus *Pericyclus*, Mojsisovics.[2] The type-specimen is preserved in the "Griffith Collection" in the Museum of Science and Art, Dublin, and has been re-figured (as *Pericyclus fasciculatus*) by Dr. A. H. Foord in his "Monograph on the Carboniferous Cephalopoda of Ireland" (pt. iv, 1901, pl. xxxvii, figs. 5*a*, *b*); where its locality is given as Millicent, Clane, county of Kildare.

In the same work M'Coy also describes the species *Nautilus* (*Temnocheilus*) *furcatus* (p. 21, pl. iv, fig. 13). The type-specimen was most probably from Cork, for it was lent to M'Coy by Dr. Haines of that place, and judging from M'Coy's figure it was much distorted and compressed like so many of the fossils from that locality. Its present location is unknown. Dr. Foord states that it is not in the "Griffith Collection" in the Museum of Science and Art, Dublin, in which many of M'Coy's types are contained, but says that "the excellent figure of it in the 'Synopsis' renders it easy of identification." Although this species has been previously referred to Mojsisovics'

[1] Geol. Mag., Dec. IV, Vol. X, No. 471, September, 1903.
[2] Abhandl. d. k.-k. geol. Reichsanst., Wien, vol. x (1882), p. 141.

genus *Pericyclus*,[1] Dr. Foord has shown (*op. cit.*, pt. iv, 1901, pp. 137, 138) that the specimens described as *P. furcatus* are only examples of *P. fasciculatus* that have lost the test; he has therefore united the two species, adopting M'Coy's name *fasciculatus* for two reasons, "(1) because it was the first to be described in the 'Synopsis,' and (2) because it shows the ornaments on the test, whereas the name *furcatus* was applied merely to the cast of the shell."

The following is Dr. Foord's emended description of the species:—

"Shell discoidal, somewhat inflated, umbilicated; greatest thickness at the umbilical margin, where it is two-thirds of the diameter of the shell; height of outer whorl two-fifths of the diameter of the shell. Whorls not fewer than five (exact number not ascertainable); inclusion about one-half; umbilicus somewhat less than one-half of the diameter in width, with subangular margin, deep, partly exposing the inner whorls. Whorl reniform in section, about twice as wide as high, not much indented by the preceding whorl; periphery broadly convex, continuous with the convex sides; inner margin rather wide, well defined, very steep.

"Body-chamber occupying at least one whorl; aperture not seen. Chambers of moderate depth; suture-line as in pl. xxxvii, fig. 6. Test ornamented with strong, rounded, transverse ribs, which generally begin to bifurcate at or near the umbilical margin, the bifurcation in some specimens not taking place till the middle of the side is reached. The ribs form a broad, shallow sinus in crossing the periphery, the sinus sometimes becoming sharply concave in the median line; the intervening concave spaces wider than the ribs. Covering the ribbing and interspaces there are a series of very distinct, sharp, raised lines, disposed irregularly as regards their distance apart; on the ribs about two of the lines occupy the space of 1 mm., but between them the lines are a little more spread out. The tendency of these fine ribs to form bundles is well marked, and made the name 'fasciculatus' given by M'Coy to the specimen bearing the test singularly appropriate."

The reference to the suture-lines is rather misleading, because the figure which Dr. Foord gives is taken from an immature specimen, and shows neither the characteristic pointed lateral lobe nor the existence of a second smaller pointed lobe on the inner area of the whorl. These suture-lines are stated to be those "of a small specimen where the diameter of the shell is about 30 mm.," but it correctly drawn they appear to have been taken from the young stage of a rather large individual, because the lateral lobe is still rounded, whereas in some of the specimens described below this lobe is distinctly pointed at a diameter of less than 30 mm. (See Figs. 2, 3, and 4.) The suture-line of the original of Dr. Foord's pl. xxxvii, figs. 2*a*, *b*, which is in the National Collection [No. C. 5933], is therefore given in the accompanying drawing (Fig. 1). In the figure in the "Catalogue of Fossil Cephalopoda, British Museum," pt. iii, p. 150, fig. 71*c*, the lobe on the inner margin of the whorl should have been represented a little deeper and more acute.

[1] See Cat. Foss. Ceph. British Museum, pt. iii (1897), p. 149.

M'Coy gives only two measurements of his *G. fasciculatus*, viz., diameter one inch six lines [= 38 mm.], and thickness of last whorl eleven lines [= 23·5 mm.], but according to Dr. Foord's figure of the type-specimen the other dimensions are:—radius,[1] 22·5 mm.; width of umbilicus, 11 mm.; and height of last whorl, 17 mm. The dimensions of *furcatus*, examples of which are, he says, generally elliptical, M'Coy states to be as follows:—diameter, two inches seven lines [65·5 mm.]; diameter [or height] of last whorl, thirteen lines [27·5 mm.]; thickness, eleven lines [23·5 mm.].

Fig. 1.—Suture-line of *Pericyclus fasciculatus*. Drawn of the natural size from a specimen in the British Museum [No. C. 5933] from the Carboniferous Limestone, Clane, co. Kildare, Ireland. In this and the following figures the short dotted lines crossing the suture-line indicate the position of the umbilical margin, the short line at each end marking the position of the suture of the shell, or 'line of involution.'

In his Monograph Dr. Foord gives no dimensions of the species, but figures four examples. Of these one (pl. xxxvii, figs. 2*a*, *b*) is the undistorted specimen from Clane belonging to the British Museum and referred to below; another is M'Coy's type of *fasciculatus* (pl. xxxvii, figs. 5*a*, *b*), the dimensions of which are given above; a third is a somewhat distorted example from Midleton, in the county of Cork; whilst the fourth is a smaller specimen from Glenbane East, in the county of Limerick. For the sake of comparison with the English examples recorded below the dimensions of the third and fourth specimens are here given. The measurements of the Midleton specimen are:—diameter, 65 mm.; radius, 40 mm.; width of umbilicus, 21·5 mm.; height of outer whorl, 28·5 mm.; thickness of outer whorl, 35·5 mm.: those of the example from Glenbane being:—diameter, 34 mm.; radius, 20 mm.; width of umbilicus, 10 mm.; height of outer whorl, 14·5 mm.; thickness of outer whorl, 21·5 mm.

In Ireland, according to Dr. Foord (*op. cit.*, pt. iv, 1901, p. 138), the species occurs at Cork, Midleton, Blackrock, in the county of Cork; Glenbane, in the county of Limerick; and Clane, county of Kildare. The species, however, is rare in England; hence the following particulars respecting English examples which have come under the writer's notice may not be without interest. In the list of fossils appended to the Geological Survey memoir on "The Geology of the Carboniferous Limestone, Yoredale Rocks, and Millstone Grit of North Derbyshire," 1887, the species is recorded from North Staffordshire (p. 182), the specimen referred to being from Beeston Tor, in North Staffordshire, about 1 mile east of Grindon, and now preserved in the Museum of Practical Geology, Jermyn Street.

Until comparatively recently the British Museum contained only one example of this species [No. C. 5933] having the locality

[1] A line drawn from the centre of the coil to the periphery of the shell.

recorded; this was from the Carboniferous Limestone of Clane, co. Kildare, Ireland, and was presented to the Collection by Dr. A. H. Foord. It was figured (under the name *Pericyclus furcatus*) in the "Catalogue of the Fossil Cephalopoda in the British Museum (Natural History)," pt. iii, p. 150, fig. 71, and has been re-figured (under the name *Pericyclus fasciculatus*) by Dr. Foord in his "Monograph on the Carboniferous Cephalopoda of Ireland," pt. iv (1901), pl. xxxvii, figs. 2*a*, *b*, its suture-line being given in Fig. 1 accompanying this paper. Its dimensions are:—diameter of shell, 51 mm.; radius, 29·5 mm.; width of umbilicus, 17 mm.; height of outer whorl, 20 mm.; thickness of outer whorl, 35 mm.; height of outer whorl above preceding whorl, 17 mm. As nearly as can be ascertained the outer whorl bears 34 ribs. It lacks the test and agrees with M'Coy's type of *furcatus*. Besides this, the National Collection contains two examples [No. C. 5773], 34 and 17·5 mm. in diameter respectively, like M'Coy's type of *fasciculatus*, but unfortunately the locality whence they were obtained has not been recorded.

In 1901, however, a well-preserved but imperfect example from the Carboniferous Limestone of Kniveton, 2 miles north-east of Ashbourne, Derbyshire, was presented to the British Museum [No. C. 7961] by the Rev. F. St. John Thackeray, M.A., F.G.S. It is a natural internal cast, and consists of the inner whorls up to a diameter of about 22 mm. that are entirely septate, and of about one-half of the succeeding whorl, which is about 40 mm. in diameter, and belongs to the body-chamber. At its greatest diameter, 40 mm., the other dimensions appear to have been:—radius, 23 mm.; width of umbilicus, 14 mm.; height of outer whorl, 14 mm.; thickness of outer whorl, 27 mm. There are eighteen or nineteen ribs in the last half-whorl. At a position on the inner whorls where the shell has a radius of 9 mm. the suture-line is displayed on both the peripheral area and the umbilical margin, and somewhat less clearly on the inner area or umbilical zone of the whorl. It is represented in the accompanying figure. Compared with "the suture-lines of a small

Fig. 2.—Suture-line of *Pericyclus fasciculatus*. Drawn of the natural size from a specimen (where radius is 9 mm.) in the British Museum [No. C. 7961] from the Carboniferous Limestone, Kniveton, 2 miles N.E. of Ashbourne, Derbyshire.

specimen where the diameter of the shell is about 30 mm.," given by Dr. Foord (*op. cit.*, pl. xxxvii, fig. 6), we note in the present specimen that where the radius is only about 10 mm. and the diameter therefore not more than about 18 mm., the sides of the external lobe are more nearly parallel, the external saddle is rounder, the lateral lobe is even at this diameter distinctly pointed, whilst a pointed, acutely V-shaped lobe is present on the inner area or umbilical zone of the whorl. No such lobe as the last-mentioned is indicated in Dr. Foord's figure, but it may be that the short line at each end of the suture-line is intended

to denote the position of the umbilical margin, and not that of the 'line of involution,' or, as it is generally termed, the 'suture of the shell.'

Besides four specimens from Irish localities—two from Ireland, but locality uncertain; one from Limerick; and one from Kildare—the Museum of Practical Geology contains two English examples, one being the specimen from Beeston Tor, 1 mile east of Grindon, in North Staffordshire, already referred to, and the other from near Matlock, in Derbyshire.[1]

The Beeston Tor specimen [No. 8860] is a small natural internal cast bearing portions of the test in a very eroded condition. Its dimensions are:—diameter of shell, 20 mm.; radius, 12 mm.; width of umbilicus, about 7 mm.; height of outer whorl, 6·5 mm.; thickness of outer whorl, 16 mm.; height of the outer whorl above preceding, (?). There are about 30 ribs in the outer whorl, the last half-whorl bearing 14. The specimen does not appear to be at all crushed, but, as will be seen from its dimensions, it is relatively thicker than any of the other examples. The suture-lines are not shown.

The example from near Matlock [No. 6696] is also a natural internal cast; besides the outer whorl, which is a little imperfect on one side, about a quarter of the penultimate whorl is displayed, the rest of the inner whorls being probably present, though occluded by matrix. Its dimensions are:—diameter of shell, 32 mm.; radius, 18 mm.; width of umbilicus, 12 mm.; height of outer whorl, 12 mm.; thickness of outer whorl, 21 mm.; height of outer whorl above preceding, about 9 mm. There are 34 ribs in the outer whorl. A little less than one-half of the outer whorl is occupied by the body-chamber; several suture-lines are well displayed; the last is represented in the accompanying figure. This specimen is relatively

Fig. 3.—Suture-line of *Pericyclus fasciculatus*. Drawn of the natural size from the last septum of an example (at a radius of 13·5 mm.) in the Museum of Practical Geology [No. 6696] from the Carboniferous Limestone, near Matlock, Derbyshire.

thinner than the Beeston example, for at a radius equal to the greatest radius of that specimen this shell is only 13 mm. thick.

Through the kindness of Dr. Wheelton Hind I have been able to examine two examples in his collection that came from Bradbourne, about 2 miles north of Kniveton, Derbyshire. Both are internal casts. One is a fairly well preserved cast of the outer whorl, with the inner whorls present, although broken on one side and obscured by matrix on the other; it has the following dimensions:—diameter, 34·5 mm.; radius, 20 mm.; width of umbilicus, 16·5 mm.; height of outer whorl, 11·0 mm.; thickness of outer whorl, 21·5 mm.; height of outer whorl above preceding whorl, 9 mm. About five-sixths of the

[1] My best thanks are due to Mr. E. T. Newton, F.R.S., for the facilities given me to examine these fossils.

last whorl is occupied by the body-chamber; the last three suture-lines are clearly visible at the commencement of the outer whorl (see accompanying figure). Towards the anterior end of the body-chamber one side of the shell bears traces of an injury during the

FIG. 4.—Suture-line of *Pericyclus fasciculatus*. Drawn of the natural size from the last septum (at a radius of 13·5 mm.) of an example in the collection of Dr. Wheelton Hind, from the Carboniferous Limestone of Bradbourne, about 2 miles north of Kniveton, Derbyshire.

life of the animal that has interfered somewhat with the regular sculpturing of the shell, but the original number of the ribs crossing the periphery can be ascertained to be 36. As will be seen from the dimensions, this specimen is more widely umbilicated than the example from Kniveton.

The other specimen consists of about one-half of the outer whorl of a rather more finely sculptured example of about the same diameter as the fossil just described, that has been distorted into an elliptical form. It exhibits no septa, and most likely formed part of the body-chamber; the ribbing is a little irregular at the anterior part of the specimen, but in the half-whorl there appear to have been about 22 ribs on the central portion of the peripheral area.

The following table enables the type-specimen of M'Coy, the British Museum example from Clane, and the English examples referred to in the present paper to be more readily compared with one another, the specimens being arranged according to their respective diameters. (i) is the example from Beeston in the Museum of Practical Geology [No. 8860]; (ii), the specimen from near Matlock in the same collection [No. 6696]; (iii), the nearly complete example from Bradbourne in the collection of Dr. Wheelton Hind; (iv), M'Coy's type-specimen of '*G.' fasciculatus* in the Museum of Science and Art, Dublin; (v), the specimen from Kniveton in the British Museum Collection [No. C. 7961]; (vi), the example from Clane in the same collection [No. C. 5933]. The measurements are in millimetres.

	i	ii	iii	iv	v	vi
Diameter of shell	20 (100)	32 (100)	34·5 (100)	38 (100)	40 (100)	51 (100)
Radius of shell	12 (60·0)	18 (56·2)	20 (57·9)	22·5 (59·2)	23 (57·5)	29·5 (57·8)
Width of umbilicus	7 (35·0)	12 (37·5)	16·5 (47·8)	11 (28·9)	14 (35·0)	17 (33·3)
Height of outer whorl ...	6·5 (32·5)	12 (37·5)	11 (31·8)	17 (44·7)	14 (35·0)	20 (39·2)
Thickness of outer whorl	16 (80·0)	21 (65·6)	21·5 (62·3)	23·5 (61·8)	27 (67·5)	35 (68·6)
Height of outer whorl above preceding whorl.	?	*c.*9 (28·1)	9 (26·0)	?	?	17 (33·3)
No. of ribs in outer whorl	*c.* 30	34	36	*c.* 33?	36	34

From the above table of measurements, it will at once be seen, firstly, that the Beeston example is relatively thicker than the others, and secondly, that there is some irregularity in the height of the outer whorl and of the width of the umbilicus in specimens iii and iv. In iii (Dr. Wheelton Hind's specimen from Bradbourne) the umbilicus seems to be relatively wider and the height of the whorl narrower

than usual, whereas the reverse is the case in iv (M'Coy's type-specimen of '*G.' fasciculatus*). The former does not appear to be distorted, and is therefore a more evolute form than the rest, but in the absence of other similar specimens it is provisionally at least included in M'Coy's species. M'Coy's specimen is distorted, and the irregularity noted may be due to this distortion, for, judging from Dr. Foord's figure of the fossil (pl. xxxvii, fig. 5*a*), the anterior extremity of the outer whorl appears to be abnormally high. It may be mentioned that the examples of the species figured by Dr. Foord differ considerably in their relative dimensions.

The English localities, then, of *Pericyclus fasciculatus*, so far as known to the present writer, are confined to the western part of Derbyshire and the adjoining part of Staffordshire. They are:—(i) near Matlock, Derbyshire; (ii) Kniveton, 2 miles north-east of Ashbourne, Derbyshire; (iii) Bradbourne, about 2 miles north of Kniveton and about 10 miles south-west of Matlock, Derbyshire; and (iv) Beeston Tor, in North Staffordshire, about 1 mile east of Grindon and about 7 miles west of Bradbourne.

NOTICES OF MEMOIRS, ETC.

On the Igneous Rocks of the Berwyns. By T. H. Cope and J. Lomas.[1]

OWING to cross folding a dome-like structure has been impressed on the Berwyns. From the axis which lies about Llanrhaiadr-yn-Mochnant and Craig-y-Glyn the beds dip outwards on every side. The arch of the dome has been denuded, so that we get shales and limestones of Llandeilo age occupying the central area, while slates, grits, and limestone of Bala age form an almost continuous ring of hills on the margins.

Igneous rocks are associated with the sedimentaries. Three bands in the peripheral series can be traced continuously for a distance of thirty miles from the Mountain Limestone beds which overlap the series on the east, through the hills above Corwen and Bala to the Vyrnwy watershed. A fourth band also occurs in this series about Llanarmon.

In the central area other igneous rocks are exposed, generally of a more acid type.

The igneous series have been regarded as contemporaneous volcanic ashes, and recorded as such in the Survey maps. We have failed to find any instance of undoubted contemporaneous action, and regard all the igneous as intrusive. In places they are seen to cut across the sedimentaries at right angles to the strike.

In this paper we only deal with a small part of the peripheral series as displayed about Llansantffraid-Glyn-Ceiriog where the river Ceiriog in cutting a deep gorge across the strike of the beds has exposed magnificent sections.

[1] Abstract of a paper read before the British Association, Southport, Section C (Geology), September, 1903.

Sheet No. 1.—The outermost bed is well seen in the quarries at Coed-y-Glyn, on the west side of the valley, and in a small cutting on the hillside on the east side. It is 45 feet thick on the level of the road, but thins out rapidly to the north, as at a short distance away it only measures 28 feet. Baked slates lie in contact on both its upper and lower surfaces.

The rock consists of a felted aggregate of felspar microliths, and is aphanitic in texture. The upper margin for 5 feet and the lower part for 2 feet are amygdaloidal. Near the upper surface the microscope reveals flow-brecciation, broken fragments of the rock lying in a bond of grey translucent chalcedony.

Sheet No. 2.—This band, about 165 feet thick, has been quarried extensively on the face of the steep crags overlooking Pandy, at Cae Deicws, and in the large quarry opposite Coed-y-Glyn. Indurated slates and grits border the sill on both surfaces, and large masses of slate occur as inclusions. A band of white rock of very varying thickness occupies the middle, which under the microscope shows large idiomorphic quartz and orthoclase felspar crystals in a felsitic ground-mass. The margins are intensely sheared, grey in colour, and include a great number of slate and limestone fragments along with angular pieces of the white uncleaved central portion.

Sheet No. 3.—This sheet is well seen in Coed Errwgerrig, and can be traced across the bed of the river to the east side of the valley at Cwm Clwyd. While the main mass resembles Sheet No. 2 in composition, it includes fragments of quartz felsite, felsite breccias, and nodular rhyolites arranged in parallel bands.

It is 190 feet thick, and has caused intense metamorphic action on the grits above and slates below.

Sheet No. 4 is best seen at Hendre Quarry, where it is worked extensively, and locally known as the Glyn 'Granite.'

It is an analcite-diabase, 96 feet thick, of coarse texture in the middle and finer grained towards the margins. The slates in contact are converted into compact spotted slate.

Intrusions of similar age and almost identical character have been described from Counties Donegal, Armagh, Wicklow, and other parts of Ireland, and a close parallelism can be drawn between these rocks and those in the Berwyns. The intrusions of Sheets Nos. 1, 2, and 3 probably date from the interval between the deposition of the Bala series and the overlying slates and grits of Wenlock age. No. 4 may be of a later date.

REVIEWS.

I.—The Palæontographical Society.

THIS Society, founded in 1847 for the publication of monographs on British fossils, has just completed its fifty-seventh volume, for 1903, which is now being issued to subscribers. It is one of the largest and most varied volumes hitherto published by the Society, and is illustrated with no less than 48 plates. It contains

instalments of six monographs devoted to Fishes, Mollusca, Trilobites, and Graptolites. The second part of Dr. Smith Woodward's Monograph of Chalk Fishes resembles the first part in being illustrated by explanatory restored sketches in addition to the usual lithographs of fossils. Mr. Woods completes the first volume of his Cretaceous Lamellibranchia; and Dr. Wheelton Hind finishes his Monograph of Carboniferous Lamellibranchiata, apart from a brief Appendix which is to appear in 1904. Dr. A. H. Foord is to be congratulated on finishing his important Monograph of the Carboniferous Cephalopoda of Ireland; and subscribers will express the hope that he may soon supplement it by another volume treating of the similar fossils of Great Britain. Mr. Cowper Reed begins a new Monograph of the Lower Palæozoic Trilobites of Girvan, which are very numerous, though for the most part fragmentary. The Misses Elles and Wood contribute another valuable section of their Monograph of British Graptolites, the descriptive portion this year relating to the family Leptograptidæ. The Annual Report of the Society is now prefixed to the volume, and from it we learn that during the year ended 31st March, 1903, there was a serious reduction in the income. New subscribers are needed to replace many recent losses by death, and we commend the Palæontographical Society's guinea's-worth to the notice of all geologists who are not yet acquainted with it. The Secretary of the Society, from whom all information may be obtained, is Dr. A. Smith Woodward, British Museum (Natural History), South Kensington, London, S.W.

II.—Memoirs of the Geological Survey: England and Wales.

1.—The Geology of the Country near Chichester. (Explanation of Sheet 317.) By Clement Reid, F.R.S., F.G.S., etc.; with contributions by G. W. Lamplugh, F.G.S., and A. J. Jukes-Browne, F.G.S. 8vo; pp. iv and 52, paper cover; price 1*s.* 1903. Colour-printed sheet, No. 317, price 1*s.* 6*d.* (separately sold).

2.—The Geology of the Country around Torquay. (Explanation of Sheet 350.) By W. A. E. Ussher, F.G.S. 8vo; pp. iv and 142; paper cover, price 2*s.* 1903. [The map (New Series, No. 350) was published in 1898; the present memoir is issued as an explanation of that map.]

1.—The publications of the Geological Survey of England and Wales again claim our attention, the first of the present series relating to the country near Chichester. This memoir takes in an area of 216 square miles, all in the county of Sussex, and includes a large tract of the South Downs, which presents a bold escarpment of Chalk stretching from east to west and fronting to the north, overlooking the great Wealden area, a portion only of which is represented on the map (Sheet 317). It embraces the picturesque regions of Midhurst, Petworth, and Pulborough, on the north, and the low-lying fertile tracts of drift-gravel and brickearth on the south. The Chalk Down descends gradually southwards to a low

level, and forms a syncline in the hollow of which Lower Eocene strata are preserved. On the south the Downs usually end in a lower bluff which marks the position of an ancient, partly obliterated sea-cliff, and below this is a flat coastal plain which extends continuously to the sea.

One river of importance, the Arun, traverses the country from north to south, and with its tributaries drains about two-thirds of the area. Over the remaining area most of the water escapes by underground courses to the Lavant, or drains into small streams which reach the sea near Bognor, and at Pagham Harbour—where a submarine forest has been observed, and a deposit of *Scrobicularia* clay occurs—since reclaimed.

Within the area lies the ancient town of Chichester, with its cathedral and its seven churches and other ancient relics; Arundel, with its castle (both giving titles to earldoms); with several other towns, and numerous villages. All through this district the population has taken up its abode where water was easily obtainable, no place of importance lying on the Weald Clay or Gault, nor on the high Downs, where water can only be obtained by means of deep wells.

Most of the district is devoted to agriculture and to sheep pasture, but also contains much woodland—beech on the Downs and oak in the Weald.

The Weald Clay forms wet and rather poor land, much of it being laid down in pasture. In former times it was extensively covered with forests (called *hursts*), hence the suffix to the names of many towns, as Pens*hurst*, Staple*hurst*, Mid*hurst*, etc. It was termed 'Oak-tree Clay' by William Smith, although the term was more generally used by Smith for the Kimeridge Clay, but sometimes also for the Gault. The oak was chiefly used in obtaining charcoal for the old iron furnaces once common in the Weald. The ironstone was largely smelted, particularly in the western part of the area (H. B. Woodward's Geology, pp. 363–364). Of course, with the introduction of coal for iron-smelting the very limited production of the highly superior *charcoal-made* Sussex iron ceased as an industry, and neither mines nor manufactures any longer exist within the district.

The once famous 'Petworth' or 'Sussex Marble,'[1] a fresh-water limestone composed almost entirely of two or more species of *Paludina*, *P. sussexiensis* and *P. fluviorum*, appears to be no longer worked. It was extensively used in ecclesiastical buildings, monuments, and altar-pieces in mediæval times. Some of the recumbent figures of Knights Templar in Winchelsea Church are carved out of Petworth marble.

The formations represented on Sheet 317 embrace Recent Alluvial deposits; Pleistocene, Brickearths, Gravels, Flint-rubble, Clay with Flints (overlying the Chalk); Eocene, comprising London Clay, Pebble Beds, and Reading Beds; Upper Cretaceous Series, Upper,

[1] Known also as 'Bethersden Marble' and 'Laughton Stone.'

Middle, and Lower Chalk; Selbornian, Upper Greensand, and Gault; Lower Cretaceous or Lower Greensand, Folkestone Beds, Sandgate Beds, Hythe Beds, Atherfield Clay, and lastly the Weald Clay.

Nothing is yet known about the strata which underlie the Weald Clay; but as far as can be judged from neighbouring areas, a great thickness of Lower Cretaceous and Jurassic rocks would be met with. It is not probable that any minerals worth mining occur within several thousand feet of the surface.

Figures of fossils from the Gault, the Lower Chalk, the Middle and the Upper Chalk are given in the text, together with lists of fossils and sections. Two sections north and south across the area (1) from Easebourne across Heyshott Down (745 feet) and Goodwood Racecourse (542 feet) to Rumboldswyke, and (2) from Broadford Bridge across Kithurst Hill (700 feet) to Highdown Hill (266 feet), form the frontispiece to this little memoir, which is clearly written, but less interesting geologically than one would have expected, considering its well-marked physiography. The colour-printed geological map is extremely well executed and clear.

Referring to some of the steep slopes of the Lower Chalk (p. 22), Mr. Clement Reid observes: "Some parts of the slopes are too steep for cultivation, and are clothed, and seem always to have been clothed, with ancient hanging woods, locally known as 'hangers,' principally of beech, with some undergrowth of holly and hazel. So little of the primæval forest is anywhere left in Sussex, except on the heavy clay lands of the Weald, that it is interesting to find these small outliers still remaining. They contain rare woodland animals and plants, such as one does not find in the forests of the Weald. Among the mollusca both *Helix obvoluta* and *Clausilia Rolphii* are to be found, and among the plants Solomon's seal and Herb-Paris. In one of these woods the zigzag connecting the Roman Stone Street with the lowlands is well seen."

2.—Mr. W. A. E. Ussher, the author of the present Explanatory Memoir, has had the advantage of following in the footsteps of one of our most able and distinguished of early Devonian geologists, R. A. C. Godwin-Austen, whose map appeared in 1840. Another able worker, Dr. Holl, brought out a map in 1868, with some additional details, and he was followed a few years later by Mr. Arthur Champernowne, who commenced a careful survey of the neighbourhood of Totnes. Mr. Horace B. Woodward, at Torquay, and Mr. Ussher, at Paignton, commenced the official re-examination of the district in 1874–75.

Mr. Champernowne, shortly before his death, generously handed over the results of his geological labours to the Survey, and to Mr. Ussher was entrusted the task of embodying these results in the official publications.

The new map (Sheet 350) was published in 1898, and the present memoir is issued as an explanation of that map.

The district is one of exceptional difficulty owing to the want of persistence in well-marked lithological horizons, and to stratigraphical

TABLE OF FORMATIONS, WITH FOREIGN EQUIVALENTS AND LOCALITIES.

Pleistocene.	Alluvium		Of River Dart and tributaries, and of streams with seaward outlets.
	River Terrace Gravels		Dart Valley above Totnes; north of Paignton.
	Submerged Forests		Tor Abbey Sands; the Paignton coast; Blackpool, near Stoke Fleming.
	Head		Traces on Raised Beach platforms at Hope's Nose, Churston Cove, etc., not shown on the map.
	Raised Beaches		Hope's Nose; Thatcher Stone; Churston Cove; near Berry Head; Sharkham Point.
	Cavern Deposits		Kent's Cavern; Windmill Hill Cavern, Brixham; Happaway Cavern; Anstey's Cove, Cavern.
Lower New Red (Permian).	Conglomerate and Breccia, with beds of Rock Sand		Oddicombe Beach; St. Mary Church; west of Torquay; Paignton.
	Clays with sandy beds, Brecciated Clays		Petit Tor; north of Torre Station; Edginswell; north of Compton; etc.
	Sandstone outliers, and in fissures in limestone		Outliers near Waddeton, Brixham, Durl Head; fissures near Churston Cove and Berry Head.
Upper Devonian.	Cypridinen Schiefer		Red and greenish slates with Entomostraca: Anstey's Cove, Goodrington.
	Büdesheim Schiefer		Red slates and slaty mudstone: Saltern Cove and Ivy Cove.
	Knollen Kalk and Kramelzel ...		Slates, etc., with calcareous nodules, compact concretionary limestone: Saltern Cove, Ivy Cove, Ilsham.
	Goniatiten Schichten		Irregular liver-coloured shaly limestone: Petit Tor Combe, Anstey's Cove, Ilsham.
Middle Devonian.	*Rhynchonella cuboides* Zone ...		Pale massive sub-crystalline limestone: Lummaton, Petit Tor, Ilsham, etc. Bedded limestone: Goodrington, Elbury, etc.
	Stringocephalen Kalk		Massive and bedded limestones, mostly coralline: Babbacombe, Torquay, Brixham, Ipplepen, Marldon, Dartington.
	Stringocephalen Schiefer		Slates replacing limestone in Dartington Park, Broadhempston, etc.
	Eifler Kalk		Thin-bedded slaty and shaly limestones: Hope's Nose, Redgate Beach, Daddy Hole, Mudstone Bay, Harbertonford, etc.
	Eifler Schiefer		Fossiliferous, irregular, partly calcareous slates: Berry Park. More even slates: Mudstone Bay anticline, etc.
Lower Devonian.	Upper Coblenzien:	Staddon Grits.	Hard quartzose grits; red, dull green, and grey grits with slates and shales; top beds west of Hope's Nose Raised Beach; main outcrop from north end of Southdown Cliff westward, Warberry Hill, Lincombe Hill, Torquay, Cockington, etc.
	Lower Coblenzien and Taunusien (Siegener Grauwacke).	Meadfoot Beds, including Looe Beds.	Dark grey slates, knubbly and irregular, with compact grit beds, and fossiliferous calcareous bands. Dark grey slates with silty films, occasional beds of grit and lenticles of limestone. Beds of Looe and Ringmore type on coast, south of Man Sands, locally red-stained.
	Gedinnien (?):	Dartmouth Slates.	Variegated, purple, green, etc., glossy slates, grit shales (quartzo-phyllades), and occasional beds of hard grit; Scabbacombe Head, to south-west corner of map.

complications of a most intricate character, due to folding and faulting. Much detailed work was therefore necessary before even the broader tectonic features could be deciphered.

The three main divisions of the Devonian formation have now been made out and their boundaries ascertained with approximate accuracy, and brought into line with their Continental equivalents.

Seventeen sections in the text serve to illustrate the numerous faults, folds, and contortions which the Devonian series of Torquay have undergone, and graphically express the difficulties in tracing out and mapping this varied and complicated area. The annexed table may serve to show the several subdivisions which are recognised, together with their foreign equivalents and localities (see p. 38).

The author furnishes lists of fossils from Lummaton (pp. 66–68), and refers to the Rev. G. F. Whidborne's monograph on the Devonian Fauna (Pal. Soc. Mon.) for authorities. Summarised, they show: Trilobita 17, Phyllocarida 1, Ostracoda 9, Entomides 2, Cephalopoda 16, Gasteropoda 48, Lamellibranchiata 30, Brachiopoda 72, Discina 1, Crania 1, Bryozoa 14, Echinodermata 10. In chapter vii, under Post-Tertiary and Recent Deposits (p. 13), there is given a summary of cavern deposits, including the historic caves of Kent's Hole, Torquay, and Brixham Cave. Lists of the animals discovered are given, and, under the account of the Raised Beaches, carefully prepared lists of the Mollusca.

There are no economics to deal with in this area beyond Building-stones, Road-metal, and Ornamental Marble works in which slabs of Devonian Coral limestone are chiefly employed, good examples of which may be seen in the Survey Museum and the Geological Gallery of the Natural History Museum in Cromwell Road.

The six-inch maps of this area have been deposited in the Survey Office for reference, and copies may be obtained at cost price.

REPORTS AND PROCEEDINGS.

I.—Geological Society of London.

November 18th, 1903. — Sir Archibald Geikie, D. Sc., F.R.S., Vice-President, in the Chair. The following communications were read :—

1. "Notes on some Upper Jurassic Ammonites, with special reference to Specimens in the University Museum, Oxford." By Miss Maud Healey. (Communicated by Professor W. J. Sollas, M.A., D.Sc., LL.D., F.R.S., F.G.S.)

In the course of rearranging the Upper Jurassic fossils in the Oxford University Museum, the attention of the authoress has been called to the large amount of prevailing misconception with regard to Sowerby's species *Ammonites plicatilis* and *Am. biplex*. The type-specimen of *Perisphinctes plicatilis* (Sow.) is refigured and described. It is in the form of a cast, but only an indefinite statement exists as

to the locality from which it was derived. It appears to be an Upper Corallian form, and is usually taken as the zone-fossil of that horizon. Sowerby's two figures of *Perisphinctes biplex* represent different specimens, one of which is dismissed from consideration. The other, probably from a Kimmeridge Clay nodule found in the Suffolk Drift, is refigured and described. The authoress considers that it would be wisest to abandon the name altogether, or at least to restrict it to the abnormal specimen to which it was first attached. The original specimen of *Perisphinctes variocostatus* (Buckland) came from the so-called Oxford Clay at Hawnes, 4 miles south of Bedford; but the authoress gives evidence in favour of her belief that it was really derived from the Ampthill Clay. Sowerby's *Ammonites rotundus* is the last species figured, and it is doubtfully identified as a variety of *Olcostephanus Pallasianus* (D'Orb.). It was derived from the Kimmeridge Clay of Chippinghurst, $6\frac{1}{2}$ miles south of Oxford, and is the zone-fossil of the Upper Kimmeridge Clay.

2. "On the occurrence of *Edestus* in the Coal-measures of Britain." By Edwin Tulley Newton, Esq., F.R.S., V.P.G.S.[1]

This genus was originally described from the United States, and was afterwards recognized in beds of similar age in Russia and Australia. The genus was afterwards placed with *Helicoprion* and *Campyloprion* in the family Edestidæ. The specimen described in the present paper was obtained by Mr. J. Pringle from one of the marine bands which occurs between the 'Twist Coal' and the 'Gin Mine Coal,' in the Smallthorn sinking of Messrs. Robert Heath & Son's pits at Nettlebank (North Staffordshire). Several other marine bands, chiefly met with during the sinking of shafts in this coalfield, have been studied by Mr. J. T. Stobbs, who called the attention of the Geological Survey to the exposure from which this specimen was obtained. The specimen is a single segment of a fossil very closely resembling *Edestus minor*, and consists of an elongated basal portion, bearing at one extremity a smoothed, enamelled, and serrated crown. A description of the fossil shows that it is not to be referred to any existing species, and a new name is given to it. While it seems most in accordance with present knowledge to regard the 'spiral saw' of *Helicoprion* as the enrolled, symphysial dentition of an Elasmobranch, possibly allied to the Cestracionts, it does not seem nearly so probable that the forms referred to *Edestus* are of the same nature. In the opinion of the author the latter are more likely to be dorsal defences. The paper concludes with a bibliography of the subject.

II.—Royal Microscopical Society.

At the ordinary meeting on December 16th, 1903, Dr. Henry Woodward, F.R.S., President, in the chair, the following paper was read:—

[1] Communicated by permission of the Director of H.M. Geological Survey.

"On the Structure and Affinities of the genus *Porosphæra*, Steinmann." By Dr. G. J. Hinde, F.R.S. The well-known rounded and thimble-shaped fossils, of common occurrence in the Chalk of this country, which were named and figured as *Millepora? globularis* and *Lunulites urceolata* by the late Professor John Phillips, have been, by different authors, referred alternately to Foraminifera, Siliceous Sponges, and Cyclostomate Polyzoa. In 1878 the first-named species was placed by Dr. Steinmann as the type of a separate genus of the Hydrocorallina, which he named *Porosphæra*, and its structure was stated to resemble that of *Millepora* and *Parkeria*. From an examination of 2,900 specimens collected by Dr. A. W. Rowe and by the author from the different zones of the English Chalk, and of a singularly perfect specimen in flint discovered by Mr. H. Muller, it has been ascertained that the anastomosing fibres of *Porosphæra* are composed of four-rayed spicules which are fused together so as to form a firm, strong skeleton. In the form of the spicules and in their mode of union there is the closest resemblance to those of *Plectroninia*, Hinde, from the Eocene Tertiary of Victoria, Australia, and to the recent *Petrostroma*, Döderlein, from the Japanese Sea, and with these genera *Porosphæra* belongs to the Lithonine group of Calcisponges. The author further discovered fragments of an outer spicular crust or dermal layer on a very few specimens, which consisted of delicate, simple, rod-like, and three-rayed spicules, irregularly agglomerated, but not fused together. It is probable that a similar crust was originally present in all the forms, though it has now to a large extent been removed.

The following species were recognized and described: *P. globularis*, Phill., *P. nuciformis*, von Hagenow, *P. Woodwardi*, Carter, *P. pileolus*, *P. patelliformis*, sp.n., and *P. arrecta*, sp.n. The relative distribution and the range of size of each of these forms in the respective zones of the English Chalk are also given.

III. — Mineralogical Society, November 17th, 1903. — Dr. Hugo Müller, F.R.S., President, in the chair. Mr. R. H. Solly gave a detailed description of various minerals from the Binnenthal, five of which had not been identified with existing species. These five minerals all contain lead, arsenic, and sulphur, but sufficient material for complete analyses has not yet been obtained. Three of them are red transparent minerals having each one perfect cleavage and a similar vermilion streak, but differing crystallographically: one is apparently orthorhombic with (100), (110) = 39° 16′, (010), (011) = 52° 57′, and (001), (101) = 42° 43′; another is oblique with $\beta = 78°\ 46'$, (100), (101) = 42° 22′, and (010), (111) = 37° 3′; while the third has a zone at right angles to the perfect cleavage with angles of approximately 30° and 60°. The other two minerals, which could not be identified with any of the other sulpharsenites of lead previously described by the author, are black with metallic lustre. One of these is oblique with $\beta = 81°\ 11'$,

(100), (101) = 40° 7′, (010), (111) = 55° 26′: it has a perfect cleavage (100), and like Liveingite exhibits no oblique striations on the planes in the zone [100, 001]. The other mineral is also oblique with $\beta = 89° 40'$, (100), (101) = 46° 18′, and (010), (111) = 59° 56′: it has a perfect cleavage (100), and like Rathite exhibits numerous oblique striations on the planes in the zone [100, 001]. On fine brilliant crystals of Sartorite recently obtained by the author he has been able to confirm the oblique symmetry which he had previously announced and to determine accurately the elements $\beta = 88° 31'$, (100), (101) = 54° 45′, (010), (111) = 69° 52½′. Amongst other specimens from the dolomite of the Lengenbach in the Binnenthal, the author exhibited and described peculiar rounded crystals of Galena resembling Seligmannite, Hyalophane crystals twinned according to the Carlsbad law and showing three new forms, a green mica which was determined to be anorthic, Albite and Biotite, minerals which have not been hitherto recorded from the locality, and Barytes in green crystals. Of specimens from the Ofenhorn, the author exhibited some remarkably fine crystals of Anatase, and crystals of Laumontite, a mineral new to the locality.—Mr. L. J. Spencer described crystals of Adamite from Chili, which were remarkable for their strong pleochroism.—Mr. G. F. Herbert Smith discussed the prismatic method of determining indices of refraction. From observations of the angles of incidence and deviation the refractive index and direction of the wave-front in the crystalline medium could be found. By using pairs of faces in the same zone and different angles of incidence a series of refractive indices is obtained, which, when plotted with the direction angle as ordinate, gives in general a double curve. Three of the critical values are the principal indices, the fourth corresponding to the direction parallel to the zone-axis. The angles of polarisation with respect to the zone-axis provide a means of discriminating between the doubtful values. A description was given of an inverted goniometer whereby observations could be made in media other than air.

OBITUARY.

ROBERT ETHERIDGE, F.R.S. L. & E., F.G.S.

Born December 3, 1819. Died December 18, 1903.

In the closing days of the old year another veteran geologist has laid aside his hammer and gone to his rest, working up to the very last of his long and active life at his favourite science.

The name of Robert Etheridge is well known to all the older geologists, and, until his retirement from the public service on the 31st December, 1891, he had been a familiar figure for 34 years in the London geological world, 24 of which he was one of the Palæontologists to the Geological Survey and Museum in Jermyn Street, while for ten years he was attached to the British Museum

(Natural History), Cromwell Road, as Assistant Keeper of Geology. To the readers of the GEOLOGICAL MAGAZINE his name must have been very familiar, having appeared on the cover as one of the Assistant Editors since the 1st July, 1865, a period of 39 years.

Mr. Etheridge was a Herefordshire man, having been born at Ross on 3rd December, 1819.

His public career may be said to have commenced with his appointment in 1850 as Curator to the Museum of the Philosophical Society in Bristol, an office which he held with distinction for seven years. During five years of this period he also occupied the post of Lecturer in Botany in the Bristol Medical School, then a highly esteemed centre of medical instruction. He was besides a frequent lecturer on Geology and Palæontology in the Bristol Philosophical Institution. In 1856, when paying a visit to the Earl of Ducie, who is himself an excellent geologist, Mr. Etheridge was introduced to Sir Roderick I. Murchison, then Director General of the Geological Survey of Great Britain, as a promising geologist deserving of a more important post than Bristol could offer him, and in the following year (1st July, 1857) Etheridge, through Murchison's interest, was appointed to the Geological Survey as Assistant Palæontologist under J. W. Salter in the Museum of Practical Geology.

During the 24 years in which he was attached to the Survey, Mr. Etheridge travelled over a very large portion of the United Kingdom in assisting the younger Surveyors in their work in the field by means of his palæontological knowledge. He prepared numerous Palæontological Reports and Lists of Fossils to accompany the Memoirs of the Geological Survey upon various parts of England and Wales; he also wrote a Report on the Palæontology of Jamaica. For fifteen years he gave demonstrations annually in Palæontology to the students of the Royal School of Mines, at that time attached to the Museum of Practical Geology, Jermyn Street. With the assistance of his colleague, Mr. George Sharman, he rearranged the entire Palæontological Collection, and prepared a catalogue of the specimens which was published with a preface by Professor Huxley.

Mr. Etheridge contributed numerous papers to the Geological Society of London, which appeared in the Quarterly Journal of that Society from 1863 to 1889; the most important being his memoir "On the Physical Structure of North Devon," being a defence of the unity of the Devonian system, which had been disputed by Professor J. Beete-Jukes. It occupied 200 closely printed pages of the Journal, with lists of all the known fossils as well as of those personally collected in the field during an examination of the North Devon area, extending over several months.

He prepared a description of the Palæozoic and Mesozoic fossils of Queensland, Australia, 1872, collected by Mr. R. Daintree, F.G.S., and later on, in 1878, of the fossils brought home by the Arctic Expedition under Captain Sir George Nares, R.N., which formed a most important addition to our knowledge of the palæontology of the Polar lands.

When President, Mr. Etheridge delivered two most valuable addresses to the Geological Society of London, that in 1881 "On the Distribution of British Palæozoic Fossils," and in 1882 "On the Distribution of British Jurassic Fossils."

His other papers include descriptions of British Oolitic and Liassic Mollusca (1863); Jurassic Fossils of the Himalayas (1864); the Rhætic beds and sections (1865–66); Geology of the Bristol Coal-Basin (1866); the Stratigraphical position of Irish Labyrinthodonts (1866–67); the Geological position of the Bristol Conglomerate (1870); a new species of Echinoid from North Africa (1872); the Geology of the Watchet Area (1873); a Table of British Fossils, in Lyell (1874); Fossil Plants from Kosloo, Black Sea (1877); some New Tertiary Mollusca from Brazil (1879); on *Lepidotus maximus* (1889).

Probably the most important of Mr. Etheridge's labours has been the preparation of a Catalogue of the Fossils of the British Isles, stratigraphically and zoologically arranged — published by the Clarendon Press, Oxford, 1888 (4to, pp. 468)—of which it is to be regretted that only vol. i, comprising the Palæozoic fossils, has ever appeared, vols. ii and iii being still in manuscript, although completed up to 1888. In this work the author has catalogued 18,000 species of fossils.

Mr. Etheridge was elected a Fellow of the Geological Society of London in 1854, and served on the Council from 1863 to 1868, from 1872 to 1878, and from 1880 to 1883. He was elected President in 1880, and held the office until February, 1882. He received the Award of the Wollaston Fund from the Geological Society in 1871, and the Murchison Medal and Fund in 1880.

Mr. Etheridge was President of Section C (Geology) at the Meeting of the British Association, Southampton, 1882.

He became a Fellow of the Royal Society of Edinburgh in 1855, and of the Royal Society, London, in 1871, and served on the Council of the latter Society in 1884.

In 1890 he was elected an Honorary Fellow of King's College, London.

He has served on the Council of the Palæontographical Society for many years, and was made Treasurer in 1880, an office he retained up to the time of his death.

On the 20th October, 1881, Mr. Etheridge's services were transferred, with the sanction of the Treasury, from the Geological Survey and Museum to the British Museum (Natural History), where, in association with his friend Dr. Henry Woodward, F.R.S., the Keeper of the Department of Geology, he occupied the post of Assistant Keeper for ten years. One of the most interesting pieces of work which Mr. Etheridge accomplished was the preparation of a Stratigraphical Collection to illustrate by sections, maps, and specimens all the British sedimentary rocks. This is exhibited in Gallery XI, and is much valued by students of geology.

Mr. Etheridge was always distinguished by his courtesy and his readiness to impart scientific information to students and the public

at large, and he was greatly esteemed as an officer in the Museum, whilst his energy and activity of disposition enabled him to accomplish a very large amount of scientific work daily.

He retired from office at the end of 1891 (under Clause X of the Order in Council of 15th August, 1890). He continued, however, to be employed by the Trustees until the 31st March, 1893, when the Treasury vetoed any further engagement. A year later, on the 26th April, 1894, his old colleagues and friends, to the number of 85, gave him a complimentary dinner at the Imperial Institute, the chair being taken by Sir William Flower, K.C.B., the Director of the Museum of Natural History.

In 1896 he was presented with the first Bolitho gold medal by the Royal Geological Society of Cornwall in recognition of his distinguished services to geology, especially in the Western Counties.

But his retirement from office by no means retarded his scientific work, for he continued independently to pursue his geological and palæontological labours up to the close.

He devoted much of his time during the last twelve years to the duties of Consulting Geologist to the Dover Coal Boring, and patiently and accurately recorded foot by foot every core and sample of material brought to bank by the engineers. Many of these specimens are deposited in the Geological Department, British Museum (Natural History), where he continued to carry on his researches up to the end. He was deeply interested in the Coal Commission, was a well-known authority on the Bristol Coalfield and on that of the Kentish and the Franco-Belgian area, which he had carefully studied. In 1897 he read a paper before the Engineering Conference on "The Kent Coalfield," in which he affirmed his belief in the existence of an extensive and valuable coalfield in the South-East of England or near Dover, and explained its relation to the coalfields of the South-West of England (Bristol and Somerset), and to those of the North of France and Belgium. He made excursions to Belgium, Germany, and Austria, examined the volcanic phenomena of the Auvergne and of the Eifel districts, and wrote a short account of his visit to Central France.

He was an authority upon water-supply, and was frequently associated with the late Mr. Hawksley and his son, Mr. Charles Hawksley, M.I.C.E., and other eminent Civil Engineers, in connection with supplies for Bristol, Plymouth, London, and other large centres of population.

Mr. Etheridge was author of a Report, dated 22nd June, 1857, on Thames Mud and Thames Water, being based upon a microscopic examination of eighteen samples of mud and detrital deposits and two or more samples of water taken from the River Thames; giving a detailed account of each sample, both for the living organisms, the organic matter in a state of decomposition, and the inorganic mineral residuum; issued as Appendix II to Report relating to the Main Drainage of the Metropolis (folio, pp. 61–72). Ordered to be printed by the House of Commons, 3rd August, 1857.

He was also engaged to prepare Maps and Sections, and to give evidence before the "Royal Commission on Coal" (13th March, 1868) in relation to the Somersetshire Coalfield, and especially in reference to the probability of finding coal under the Permian, New Red Sandstone, and other superincumbent strata. [See Report of the Royal Commission on Coal, vol. i, pp. 419–422 (D. 7–10), folio; 1871.]

He leaves an only son, Mr. Robert Etheridge, jun., who has occupied the post of Curator of the Australian Museum, Sydney, N.S.W., since 1887, and was from 1879 to 1887 an Assistant under Dr. H. Woodward, F.R.S., in the British Natural History Museum, London, and previously on the Geological Survey of Scotland, with Sir A. Geikie, F.R.S. Like his father, Mr. Robert Etheridge, jun., is a distinguished palæontologist and geologist, and commenced his career as one of the staff of the Geological Survey of Victoria, Australia, under the late Dr. A. R. C. Selwyn, F.R.S.

Among his other literary labours it may be mentioned that Mr. Etheridge greatly assisted Dr. J. J. Bigsby, F.R.S., F.G.S., in the preparation of his great works (see author's prefaces to works)—(*a*) "Thesaurus Siluricus." 1868, 4to, pp. 268; (*b*) "Thesaurus Devonico-Carboniferus," 4to, 1878, pp. 450. He edited the third edition of Part i of "Illustrations of the Geology of Yorkshire," 4to, 1875, pp. x and 354, by Professor John Phillips, F.R.S., who died 24th April, 1874. He also assisted Mr. J. W. Lowry to construct his Chart of Characteristic British Tertiary Fossils, stratigraphically arranged; London, E. Stanford, 1866.

Mr. Robert Etheridge was a Corresponding Member of the Imperial Institute of Vienna, an Honorary Member of the Geological Society of Belgium, of the New Zealand Institute, the Royal Geological Society of Cornwall, the Philosophical Societies of Yorkshire and Bristol, the Geologists' Association, the Norwich Geological Society (since defunct), the Cotteswold Naturalists' Field Club, of the Hertfordshire Natural History Society, the Dorset Natural History and Antiquarian Field Club, and the Northamptonshire Natural History Society and Field Club.

A severe cold and an attack of bronchitis terminated his busy and useful life after a brief illness of three days.

List of Titles of Works and Memoirs by Robert Etheridge, F.R.S. L. & E., F.G.S.

1. "Geology; its Relation and Bearing upon Mining." (Lectures, Bristol Mining School.) 8vo; Bristol, 1859.
2. "Descriptions of new species of Mollusca, etc." [*Ceromya gibbosa*, *Astarte dentilabrum*, and *Pollicipes liassicus*]: Quart. Journ. Geol. Soc., vol. xx (1864), pp. 112–114.
3. "Note on the Jurassic Fossils collected by Captain Godwin-Austen" [in the N.W. Himalayas]: Quart. Journ. Geol. Soc., vol. xx (1864), pp. 387–388.
4. "On the Rhætic or *Avicula contorta* Beds at Garden Cliff, Westbury-upon-Severn, Gloucestershire": Proc. Cotteswold Club, vol. iii (1865), pp. 218–234.
5. "A Catalogue of the Collection of Fossils in the Museum of Practical Geology, Jermyn Street." (Preface by Professor Huxley, pp. i–lxxix.) Catalogue, pp. 1–382. 8vo. 1865.

6. "On the Palæontology of the Caribbean Area," being Appendix V to the Geology of Jamaica, by Jas. G. Sawkins, F.G.S., 1866. 8vo; pp. 306–339. (Published as a Colonial Memoir of the Geological Survey.)
7. "Section of the Rhætic Beds at Aust Cliff"; Proc. Cotteswold Club (1866), pp. 13–18.
8. "On the Physical Structure of the Northern Part of the Bristol Coal-Basin, chiefly having reference to the Iron Ores of the Tortworth Area": Proc. Cotteswold Club (1866), pp. 28–49.
9. "On the Discovery of several new Labyrinthodont Reptiles in the Coal-measures of Ireland": Geol. Mag., Vol. III (1866), pp. 4–5.
10. "On the Stratigraphical Position of *Acanthopholis horridus*, Huxley": Geol. Mag., Vol. IV (1867), pp. 67–69.
11. "On the Physical Structure of North Devon, and on the Palæontological Value of the Devonian Fossils": Quart. Journ. Geol. Soc., vol. xxiii (1867), pp. 251–252, abstract, (full text) 568–698; Phil. Mag., vol. xxxiv (1867), pp. 317–318.
12. "Supposed Permian Beds at Portskewet": Proc. Cotteswold Club, vol. iv (1868), pp. 256–258.
13. "On the Geological Position and Geographical Distribution of the Reptilian or Dolomitic Conglomerate of the Bristol Area": Quart. Journ. Geol. Soc., vol. xxvi (1870), pp. 174–191; Phil. Mag., vol. xi (1870), pp. 136–137.
14. "Description of a new genus (*Rotuloidea*) of Fossil Scutelloid Echinoderm from Saffe, N. Africa": Quart. Journ. Geol. Soc., vol. xxviii (1872), pp. 97–101.
15. "Description of the Palæozoic and Mesozoic Fossils of Queensland": Quart. Journ. Geol. Soc., vol. xxviii (1872), pp. 317–350, pls. xiii–xxviii.
16. "On the Rhætic Beds of Penarth and Lavernock": Trans. Cardiff Nat. Soc., vol. iii (1872), pp. 39–64.
17. "Notes upon the Physical Structure of the Watchet Area, and the Relation of the Secondary Rocks to the Devonian Series of West Somerset": Proc. Cotteswold Club, vol. vi (1873), pp. 35–49.
18. "Table of British Fossils illustrative of the Successive Appearance and Development in Time of the Chief Orders, Classes, or Families of Animals and Plants in Britain": pp. 623–645. Printed as a Supplement to Sir Charles Lyell's Students' Elements of Geology, 2nd ed., 1874; 3rd ed., 1878.
19. Appendix. [Mesozoic fossils found by the Rev. J. E. Cross in N.W. Lincolnshire.] Quart. Journ. Geol. Soc., vol. xxxi (1875), pp. 126–129.
20. "Notes on the Fossil Plants from Kosloo" [Black Sea]: Quart. Journ. Geol. Soc., vol. xxxiii (1877), pp. 532–533.
21. "Palæontology of the Coasts of the Arctic Lands visited by the late British Expedition under Capt. Sir George Nares, K.C.B.": Quart. Journ. Geol. Soc., vol. xxxiv (1878), pp. 568–636, pls. xxv–xxix.
22. "Notes on the Mollusca collected by C. Barrington Brown, Esq., from the Tertiary Deposits of the Solimões and the Javary Rivers, Brazil": Quart. Journ. Geol. Soc., vol. xxxv (1879), pp. 82–88, pl. vii.
23. Presidential Address to the Geological Society of London, Feb. 18, 1881, "On the Analysis and Distribution of the British Palæozoic Fossils": Quart. Journ. Geol. Soc., vol. xxxvii (1881), Proceedings, pp. 37–235.
24. "On a New Species of *Trigonia* from the Purbeck Beds of the Vale of Wardour": Quart. Journ. Geol. Soc., vol. xxxvii (1881), pp. 246–248.
25. Appendix. [*Nematophycus Hicksii*.] Quart. Journ. Geol. Soc., vol. xxxvii (1881), pp. 490–495.
26. Presidential Address to the Geological Society of London, Feb. 17, 1882, "On the Analysis and Distribution of the British Jurassic Fossils": Quart. Journ. Geol. Soc., vol. xxxviii (1882), Proceedings, pp. 46–236.
27. Presidential Address to the Geological Section of the British Association, Southampton, August 23, 1882.
28. "Stratigraphical Geology and Palæontology" (being a new and revised edition of Phillips's Manual, entirely rewritten). 1885. 8vo; pp. 712, with 33 plates.
29. "Fossils of the British Islands, Stratigraphically and Zoologically arranged": vol. i (1888), Palæozoic Species. 4to; pp. viii and 468.

Vol. ii, Mesozoic, and vol. iii, Cainozoic, completed, but still in manuscript.

30. (With Mr. H. Willett) "On the Dentition of *Lepidotus maximus* (Wagner), as illustrated by specimens from the Kimeridge Clay of Shotover Hill, near Oxford": Quart. Journ. Geol. Soc., vol. xlv (1889), pp. 356–358, pl. xv.
31. Letter on Dr. Wheelton Hind's Carboniferous Lamellibranchiata: Geol. Mag., Dec. IV, Vol. IV (1897), p. 94.
32. "On the Relation between the Dover and Franco-Belgian Coal Basins": Rep. Brit. Assoc. for 1899 (1900), pp. 730–734.

Geological Survey Memoirs to which Mr. Etheridge has contributed the Palæontology.

1. 1858. Geology of parts of Wilts and Gloucestershire (Sheet 34). Lists of Fossils by R. Etheridge.
2. 1859. Geology around Woodstock, Oxon (Sheet 45). List of Fossils by R. Etheridge.
3. 1860. Geology of part of Leicestershire (Sheet 63). List of Fossils by R. Etheridge.
4. 1861. Geology of part of Northampton and Warwick (Sheet 53). List of Fossils by R. Etheridge.
5. 1862. Geology of the Isle of Wight (Sheet 10). List of Fossils by R. Etheridge.
6. 1862. Geology of part of Berks and Hants (Sheet 12). Lists of Fossils by R. Etheridge.
7. 1864. Geology of Banbury, Woodstock, etc. (Sheet 45). Lists of Fossils by R. Etheridge.
8. 1875. Geology of the Burnley Coalfield (Sheets 88, 89, and 92). Table of Fossils by R. Etheridge.
9. 1875. The Geology of the Weald, by W. Topley, F.G.S., etc. Lists of Fossils by R. Etheridge.
10. 1875. The Geology of Rutland, by J. W. Judd, F.G.S. Appendix and Tables of Fossils by R. Etheridge.
11. 1876. Geology of East Somerset, by H. B. Woodward, F.G.S. Lists of Fossils by R. Etheridge.
12. 1876. Geology of the Lake District, by J. C. Ward, F.G.S. Appendix on New Species of Fossils by R. Etheridge.
13. 1877. Superficial Geology of South-West Lancashire, by C. E. De Rance, F.G.S. Lists of Fossils revised by R. Etheridge.
14. 1878. Catalogue of the Cambrian and Silurian Fossils in the Museum of Practical Geology (the "Wyatt-Edgell Collection"). "The specimens have been named by Mr. Etheridge, F.R.S., Palæontologist to the Geological Survey." The Catalogue drawn up by Mr. E. T. Newton, F.G.S.
15. 1880. Geology of the South of Scarborough (Sheet 95). List of Fossils revised by R. Etheridge.
16. 1881. Geology of the Country round Norwich (Sheet 66). Lists of Fossils revised by R. Etheridge.
17. 1881. Geology of the Oolitic and Liassic Rocks, Malton. Lists of Fossils revised by R. Etheridge.
18. 1881. Geology of the Neighbourhood of Cambridge. Palæontological Appendix by R. Etheridge.
19. 1881. Geology of North Wales, by A. C. Ramsay, F.R.S. (second edition). J. W. Salter's Appendix on the Fossils, revised and greatly enlarged by R. Etheridge (pp. 351–567).

Note.—Although, owing to Mr. Etheridge's death having occurred so very near before Christmas, the Publishers were prevented from issuing a portrait of him in this (January) Number, yet his friends will, we feel sure, be glad to be informed that an excellent and, as yet, unpublished photograph of him—quite lately taken by Miss Constance E. Power (daughter of Edward Power, Esq., one of Mr. Etheridge's oldest and most valued friends)—will appear in the February Number of the Geological Magazine.—H. W.